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Abbreviations

AI	artificial intelligence
API	application programming interface
BIG3	semiconductors, integrated healthcare, and future cars (South Korea)
CAO	Cabinet Office of Japan
CoC	code of conduct
CPS	cyber-physical systems
DFFT	Data Free Flow with Trust (Japan)
D.N.A.	data, network, and AI (South Korea)
DSA	Data Society Alliance (Japan)
FDI	foreign direct investment
FIR	Fourth Industrial Revolution
GII	Global Innovation Index
HR	human resources
IoT	internet of things
IPA	Information-technology Promotion Agency (Japan)
METI	Ministry of Economy, Trade and Industry (Japan)
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MSIT	Ministry of Science and ICT (South Korea)
MOEF	Ministry of Economy and Finance (South Korea)
NII	National Institute of Informatics (Japan)
OECD	Organisation for Economic Co-operation and Development
PCFIR	Presidential Committee on the Fourth Industrial Revolution (South Korea)
R&D	research and development
SDGs	Sustainable Development Goals (United Nations)
SINET	Science Information Network (Japan)
SME	small and medium-sized enterprise
STEAM	science, technology, engineering, art, and mathematics
WEF	World Economic Forum

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1. Introduction

1.1 The Fourth Industrial Revolution

In an article published by *Foreign Affairs* in late 2015, the term Fourth Industrial Revolution (henceforth FIR) was first introduced by Klaus Schwab, the executive chairman of the World Economic Forum (WEF), describing it as a technological shift that will fundamentally change the way people live, work, and in which they interact with one another (Schwab 2015). In his book *The Fourth Industrial Revolution*, Schwab goes on to further explore this notion: According to Schwab, after the previous three industrial revolutions, which were respectively triggered by the invention of the steam engine, the discovery of electricity, and the onset of computing technology, this fourth revolution will lead to a far-reaching systemic change due to its disruptive nature and the possible development of artificial intelligence (AI) technologies and will potentially lead to an increase in social inequality as a result of the decreasing importance of labor (Schwab 2017, 6-13). Based on research conducted by the WEF, he identifies new discoveries made around the areas of digital platforms, the internet of things (IoT), blockchain, advanced robotics, new materials, autonomous driving, 3D printing, as well as developments in the areas of genetics and healthcare as key drivers of the FIR (Schwab 2017, 14-24). The term "Industry 4.0" is often used synonymously with the term FIR, and its first mention even precedes that of the FIR, as it was, under the German designation *Industrie 4.0*, introduced by the German Federal Ministry of Education and Research in 2011 as a strategic approach towards industrial digitization (BMBF 2016). Even though in the media, as well as among scholars, Industry 4.0 is often used as a general term to describe this technological shift, in order to avoid confusion with the German government's strategy under the same name, I am going to use the term FIR for the remainder of this paper, unless directly citing contributions that use the term Industry 4.0.

Describing it as the "Second IT Revolution" (Lee et al, 2018, 2), another defining aspect of the FIR has been identified as not only the improvement of single digital technologies, such as AI, IoT, or big data, but also as the disruptive effect of combining those technologies with each other and the market, which, through self-organization and self-actualization, has been argued to lead to super-disruptive innovation (Lee et al, 2018, 2-6). Based on the technologies mentioned above, the emergence of cyber-physical systems (CPS) has been pointed out as a defining aspect of the FIR (WEF 2016), and, more specifically, the integration of CPSs into

industrial processes (Liao et al. 2018, 13). Besides the underlying technological advances themselves, an FIR system has been argued to be defined by interoperability through interconnection between machines, sensors and people, and information transparency that allows for contextualization of information by creating a virtual version of the physical world (Marr 2017, 11). Furthermore, it provides technical assistance to humans by both supporting decision making and assuming certain tasks, and it possesses decentralized decision-making capabilities in the form of CPSs that are able to make decisions autonomously (Marr 2017, 11). Such embedded and intelligent production systems would therewith be able to keep track of physical processes and to make decisions based on real-time communication and cooperation (Zhong et al. 2017, 616).

The FIR is predicted to fundamentally impact numerous aspects of the economy, business, national governments and international relations, the individual, as well as society overall (Schwab 2017, 28-105) and will affect areas that go beyond the industrial sector, such as work environments and skill development (Pereira & Fernando 2017, 1212). Due to the decentralization and redistribution of power made possible by advancing technologies, governments will be more and more pressed to change their approaches towards policymaking (Schwab 2015), and public institutions on regional, national, and local levels will be required to find new means to link with the business sector and citizens (Schwab 2017, 67). Key challenges that policymakers will need to take into consideration in order to facilitate digitization and industry transformation are to warrant the development, the integration, and the use of new digital technologies as well as to attend to possible skill bottlenecks and ensure investment in such technologies (Hutschenreiter et al. 2019, 23-4). Rather than just being a set of technologies, the FIR has in itself been described as a "policy-driven innovation discourse in manufacturing industries," which "aims to institutionalize innovation systems that encompass business, academia, and politics," (Reischauer 2018, 28) allowing all actors to drive forward innovation based on a shared understanding of the FIR's vision (Reischauer 2018, 28). Regulation that enables innovation has therefore been argued to be central to driving forward competitiveness on the national level, and the choice of policy will decide to which degree a certain national or regional system will be able to take advantage of the technology revolution (Schwab 2017, 74-6).

1.2 Fourth Industrial Revolution Policies of Japan and Korea

As part of its *5th Science and Technology Basic Plan*, in 2016, the Japanese Cabinet proposed a new initiative under the name of *Society 5.0*, envisioning the creation of a "Super Smart Society" (Shiroishi et al 2018, 92). The Society 5.0 strategy aims at meeting issues of both economic and societal nature by integrating virtual and physical space through utilizing technologies such as AI, big data, IoT, advanced sensors, robotics, and cloud services (CAO 2020a). The goal is to foster the transition to a new human-based society and to simultaneously innovate solutions concerning social issues as well as economic development (CAO 2020a). The realization of Society 5.0 is the focus of the recently released *6th Science, Technology and Innovation Basic Plan* (CAO 2021, 9-13), and it also takes a central role in the Abenomics policy framework (JapanGov 2020, 4-5). Furthermore, an initiative focusing on the role of industries and the manufacturing sector in Society 5.0 has been introduced under the name of *Connected Industries* (METI 2019).

In South Korea (henceforth Korea), the *Presidential Committee on the Fourth Industrial Revolution* (PCFIR) was established in August 2017, with the aim of deliberating and coordinating policy matters with regard to the development of technologies, industries, and services necessary for the national adaptation of the FIR (PCFIR 2018). Shortly thereafter, the Korean Ministry of Science and ICT (MSIT), in coordination with the PCFIR, announced a policy strategy under the name of *I-Korea 4.0* – a five-year plan to ensure the commitment across all branches of government to advancing the FIR, with the aim of fostering innovative growth (MSIT 2017, 3). In late 2017, a strategy under the name of *Growth through Innovation* (official translation from Korean *hyeogshinseongjang*) was announced, which includes the development of infrastructure and upgrading technology for the FIR, along with promoting research efforts, increasing research and development (R&D) efficiency, and developing international standards (MOEF 2017b). In addition to those FIR approaches, in 2020, the Korean Government announced the *Korean New Deal* – a strategy aiming at accelerating the transition towards a more digital and eco-friendlier post-COVID-19 economy (MOEF 2020c) with a specific focus on preparing for the advent of the FIR (MOEF 2020b). A more detailed outline of both countries' strategies is going to be provided at the beginning of the empirical chapter.

1.3 Research Question and Relevance

Utilizing an analytical framework as outlined in chapter 3 of this thesis, I am going to examine policy frameworks that are currently in place as well as such that have been announced to be enacted in the future. For this purpose, the research question devised to approach this comparison is going to be the following:

What are the similarities and differences of Japan's and South Korea's public policy approaches towards strengthening innovation processes aiming at furthering the Fourth Industrial Revolution, and how can the countries' choice of policy instruments explain their difference in innovation performance?

This paper's analysis focuses on the strategies proposed withing the previously outlined FIR innovation plans of Japan and Korea. By analyzing the current set of policies in place, I am going to establish which specific policy instruments are and which are not currently being applied by the countries' respective national FIR strategies.

As we live in a global environment in which businesses have increasingly become transnational, the influence that national systems have on innovation processes has been challenged (Nelson 1993, 4). Despite this multinationalization of the innovation process and the increase of international cooperation in areas such as research and development (Lundvall 2016, 100) as well as the existence of sectoral and regional innovation regimes (Edquist 2005, 11), it has been pointed out that basic institutions conducive to innovation and technology development, such as education systems and research facilities, are widely being provided on a national level and will, alongside public infrastructure, national laws and regulations, and the overall economic environment, heavily influence how policy in the areas of technology and science will be designed (Nelson 1993, 519). It has further been argued that the sheer complexity of interactive learning and the exchange of knowledge is, due to the compound communication it requires, easier to handle within a given system of shared norms (Lundvall 2010, 4). Therefore, although innovation processes can go beyond country borders and while the role of national systems in the process of innovation might be subject to change, I have decided to conduct my analysis on a national level since understanding how a national system of innovation works remains an important key in understanding systems of innovation at large.

Based on the respective national systems' cultures, languages, and historical experiences, institutional setups differ internationally, leading to variations in the public sector's role, the organization of the firm sector, the structure of the financial sector, and the overall R&D landscape (Lundvall 2016, 98-9). Comparisons between a given system and an ideal one are, due

to the lack of a notion of optimality in the systems of innovation approach, not possible (Edquist 2005, 20). It has therefore been suggested to compare different existing systems and stress the observed variations, since "[w]ithout comparisons between existing systems it is impossible to argue that one national system is specialized in one or the other way. Neither can we argue that one country spends much on R&D or that its system performs well – or badly" (Edquist 2005, 20). From the viewpoint of their historical backgrounds, due to a relative lack of natural resources, civilian technology policy, which necessitates development in fields such as human resources (HR) and knowledge creation, has been a crucial determinant for building systems of innovation in both Japan and Korea (Edquist 2005, 19). Additionally, the similarity of the countries' current FIR strategies – which I am going to explain in more detail in the empirical chapter – is another reason for choosing to compare those specific country cases, particularly their inclusion of societal topics rather than focusing solely on technological or economic issues. Although this might certainly be subject to further discussion, in order to define the outlines of the two national systems of innovation more clearly, I am going to assume that both Japan and Korea possess a certain degree of cultural and political homogeneity as well as political centralization, which has been suggested to facilitate the comparability of given systems (Lundvall 2010, 3).

Cornell University, INSEAD, and the World Intellectual Property Organization annually publish the *Global Innovation Index* (GII) – a report ranking 131 countries based on their innovation performance (Global Innovation Index 2020). According to their 2020 report, Korea has moved up to rank ten, breaking into the global top ten for the first time, while Japan has moved down three ranks since 2018, occupying number sixteen on the scoreboard and therewith ranking as number five within the South East Asia, East Asia, and Oceania region (Cornell University, INSEAD, and WIPO 2020, 10-6; Cornell University, INSEAD, and WIPO 2018, 80). The authors of the GII repeatedly mention FIR-related strategies and technologies as important drivers of innovation itself (Cornell University, INSEAD, and WIPO 2020, 8) as well as drivers of growth through innovation (Cornell University, INSEAD, and WIPO 2018, 8) and assign to it a key transformative role in achieving innovation aims across multiple industries (Cornell University, INSEAD, and WIPO 2017, 97; Cornell University, INSEAD, and WIPO 2016, 111). The reports also state that the GII's aim is "to assist policymakers in evaluating their innovation performance and making informed innovation policy decisions" (Cornell University, INSEAD, and WIPO 2020, xxix), and suggest certain public policy dos and don'ts in order to move up in its rankings (Cornell University, INSEAD, and WIPO 2020, 14). However, no specific information is provided on how countries are faring in the field of driving forward

FIR strategies through innovation policy, what particular strategies have been chosen to do so, or how it affects their innovation efforts. As is going to be demonstrated in greater detail in the state of the art chapter, scientific contributions in this area also lack insight into FIR policy specifics, especially for the country cases of Japan and Korea. Although literature regarding the comparison of FIR policy on a cross-national scope has to some degree been published over the last years, such as a systematic literature review covering academic contributions (Liao et al. 2018), a numbers-based approach that contrasts policy scopes on a quantitative level (Lin et al. 2017), and a study that highlights major policy trends shared by a large number of sample countries (Hutschenreiter et al. 2019), analyses on a policy level have not been provided. This opposing trend of one country gradually declining in innovation performance while the other steadily increases its performance makes taking a closer look at the cases of Japan and Korea even more pertinent.

In the face of this lack of publications investigating which exact policy areas are being focused on and which are not (both such that are targeted at directly supporting policymakers as well as scholarly ones), this paper sets out to provide a qualitative analysis and comparison of the two country cases' innovation policy frameworks targeting the advancement of the FIR. Therefore, rather than determining whether a given system can overall be considered effective or not, I am going to add an additional layer to the answer to the question as of why one national policy approach has been more successful than another: By uncovering the current variations and overlaps in the countries' policy approaches, I am going to attempt to shed some light on the specific policy instruments they focus on and therewith examine the question of how those national systems perform as they do. By creating an understanding of Japan's and Korea's precise national policy mixes and by therewith making possible a cross-national comparison, I intend to provide insights enabling both policymakers and scholars to better understand how given policy frameworks operate and how their variations might explain differences in overall innovation performance. Ultimately, by analyzing and comparing their innovation approaches on a policy level, the aim is to gain a better understanding as of why countries are doing better or worse than others in terms of innovation performance.

In conclusion of this section, it can be argued that, despite increasing international cooperation and multinationalization of innovation processes on the one hand and the existence of sectoral and regional innovation regimes on the other hand, an analysis on the national level is relevant since such policies are heavily influenced by national institutions, infrastructure, legislation, and countries' overall economic conditions. Furthermore, I have demonstrated why comparing national innovation systems to one another is, due to the lack of a notion of

optimality, more sensible than comparing them to ideal systems, and how contrasting them is the only way to truly unveil a given system's specializations and policy emphases. Comparability of the country cases of Japan and Korea is given due to their historical dependence on developing civilian technology strategies, their degree of political centralization and homogeneity, as well as the similarity of their current strategic FIR approaches. The GII, despite pointing out the importance of FIR strategies and setting out to help policymakers to evaluate and streamline their policy strategies, does not explain the policy specifics leading to the decline in ranks of one country and the rise of the other. Similarly, within academic research, specifically regarding publications examining the country cases of Japan and Korea, there is a focus on quantitative approaches rather than policy content analyses. This paper sets out to explain the reasons behind the differing levels of national innovation performance, such as the rankings provided by the GII, by looking at the specific mix of policy tools applied by the respective countries' governments to directly address the advancement of the FIR. By providing an in-depth analysis of Japan's and Korea's national policy frameworks and by allowing for their comparison, I intend to enable both the scholarly field as well as policymakers to gain a better understanding of how the countries' respective policy mixes are composed, and how their differences might explain variations in national innovation performance.

2. State of the Art

2.1 Outline: State of the Art

Laying the foundation for the analytical framework of this thesis, in the course of the following chapter, findings that have previously been made in the field are going to be analyzed in order to inform the reader on the current state of knowledge, covering the main findings of theoretical and methodological contributions to the areas of systems of innovation and innovation policy research. By focusing on secondary sources, a review of the criteria applied to analyze, categorize, and assess innovation strategies in the scientific literature is going to be conducted. The aim of this literature review is to demonstrate the current state of scientific knowledge in the field, to improve the author's as well as the readers' understanding of the topic matter, and to exhibit the body of work which this thesis' theoretical part is building upon.

After briefly explaining the overall terminology used and outlining the concepts applied in this paper in the following section, this literature review is structured into five main segments: Firstly, the roots of innovation policy research and the origins of systems of innovation theory are briefly going to be explained. In the second section of this chapter, the notion of systems of innovation and national systems of innovation, as well as the different approaches towards those theories, are going to be elaborated on. The third section is going to provide an overview on criticism directed toward national systems of innovation theory and is going to reflect on the opinions given in this regard. Fourthly, an assessment of the research approaches used to conduct cross-country comparisons of innovation policy strategies is going to be made. Finally, the fifth segment is going to shed some light on how innovation policy strategies targeted specifically at advancing the innovation of FIR technologies have been analyzed. The findings of this chapter are going to be summarized separately in a concluding section.

2.2 Definitions: Innovation Policy & (National) Systems of Innovation

By using the term *innovation*, I am referring to "the processes by which firms master and get into practice product designs and manufacturing processes that are new to them" (Nelson 1993, 4). Innovations are "new creations of economic significance" (Edquist 2005, 1) but are not necessarily only of technical nature as they can also be institutional, organizational, or social ones (Edquist 2005, 9). Innovation policy can be understood as "[a]ctions by public organizations that influence the development and diffusion of innovations" (Edquist & Hommen

2008, 9). It “incorporates science and technology policy as it aims at intervening in the innovation process as a whole – from science (exploration) to the application to specific technologies, its introduction to the market, and its wide diffusion (exploitation)” (Chaminade & Lundvall 2019, 3). Therefore, rather than merely focusing on the technological and scientific aspects of innovation, innovation policy also emphasizes institutional frameworks and wider changes necessary for new innovations to enter the market (Chaminade & Lundvall 2019, 3-4).

Although sometimes having the connotation of being consciously designed, by using the term *system*, particularly in the sense of a technological system, I am rather referring to a set of institutions which, by interacting with each other, directly influence innovative performance (Nelson 1993, 4-5). A system of innovation is thus “constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge” (Lundvall 2010, 2), its determinants being “all important economic, social, political, organizational, institutional and other factors that influence the development and diffusion of innovations” (Edquist & Hommen 2008, 8). Since countries differ considering the degree to which they are politically centralized and also considering their level of cultural and ethnical homogeneity, clearly defining the exact extent of a given *national* system can be a difficult task (Lundvall 2010, 3). More insight into the intricacies and criticism of this concept is going to be provided in the course of this literature review. Generally speaking, however, a national system of innovation can be described as a system of innovation which incorporates “elements and relationships, either located within or rooted inside the borders of a nation state” (Lundvall 2010, 2).

2.3 The Onset of Innovation Policy Research

Having discussed the definitions, I am now going to provide some insight into the origins of systems of innovation theory and the roots of innovation policy research. As one of the first scholars to address the topic of public policy in connection with the innovation process, Christopher Freeman points out the growing responsibility which governing bodies hold in providing a framework for innovation, giving particular attention to the areas of public research and development (R&D) expenditure and the role of the consumer (Freeman 1974, 287-8). Examining the global trend of extensive, and mostly public, R&D spending towards defense, nuclear and space in the post-war decades, as well as the military developments during World War II, Freeman draws a picture of how those strategies have, through their perceived success, brought on

a change in public opinion towards the importance of governmental innovation strategies (Freeman 1974, 288-96). Since R&D efforts at the time were mainly directed towards the materials and capital goods sectors, several ways in which technological innovation can reduce consumer sovereignty are stated: the lack of influence on behalf of the consumers to influence future goods, the consumers' inability to differentiate goods due to a lack of technical knowledge, as well as their inability to predict the products' long-term effects (Freeman 1974, 298-300). As policy measures counteracting this trend, Freeman identifies the provision of technological and scientific support to consumers, limitations to advertising, and regulatory standards (Freeman 1974, 300-1) while also pointing out the influence which the priorities and the focus of public research itself will have on the customers' future product choices (Freeman 1974, 306-7).

Roy Rothwell and Walter Zegveld were among the first researchers to specifically analyze the means of government intervention on the innovation process: In their study on the upcoming 1980s and 1990s, the authors identify demand, subsidies, laws and regulations, as well as technological and scientific infrastructure as general areas via which governments can influence technical innovation (Rothwell & Zegveld 1981, 49-50). A list of policy tools has also been provided, including items such as public enterprise, education, taxation, procurement, and overseas agents (Rothwell & Zegveld 1981, 61). Rothwell and Zegveld go on to give a brief overview of the policy measures taken by a number of country cases (Rothwell & Zegveld 1981, 70-1) and evaluate possible policy benefits and targets (Rothwell & Zegveld 1981, 68-9). Their analytical comparison, however, is heavily based on numbers, consisting of applying point systems based on their parameters, which provide an overview of the influence the respective areas have had on the development of key technologies (Rothwell & Zegveld 1981, 50-3) as well as a ranking of policy recommendations per tool type (Rothwell & Zegveld 1981, 73-6).

The idea of a system of innovation was first introduced in 1985, supporting the notion that not all of science is produced by universities, and that public agencies and private firms are engaging in both applied and basic research, each with their own criteria and objectives, with a large number of specialized research organizations in between those two levels (Lundvall 1985, 29). Distinguishing between technological institutions operating independently and contributing to extending the overall scientific knowledge, and R&D units aiming at finding practical applications for existing research in cooperation with the production sphere, two approaches towards furthering innovation were identified: interaction between university and industry as well as a science-based industry (Lundvall 1985, 29-33). Only shortly thereafter, the

concept of a national system of innovation was further explored: By comparing the economic development of Japan to that of the United Kingdom, Freeman demonstrates how policy has, in the case of Japan, made possible the creation of networks between public and private actors, which have allowed for the promotion of new innovation by means of the introduction and diffusion of new technologies as well as technological forecasting, ultimately enabling the country to close the previously existing technology gap (Freeman 1987, 31-90).

The systems of innovation theory overall has been stated to have originated in the general notions provided by interactive learning, evolutionary, and institutional theories (Edquist & Hommen 1999, 67-9). The concept of a national system of innovation has been argued to have developed out of dissatisfaction with the mainstream neoclassical economic theory at the given time, specifically with its inability to explain the influence of knowledge and technology on economic development (Golichenko 2016, 464). Although many scholars had already been considering technological progress as the main contributing factor to economic growth, it was seen as a non-exclusive public good which was not directly connected to the socioeconomic system (Golichenko 2016, 465). The role of institutions in driving innovation by furthering the cooperation between the various elements of the economic system had been neglected by the neoclassical growth theory (Golichenko 2016, 466).

2.4 Systems of Innovation

Setting out to further clarify the concepts already outlined above, this section is going to elaborate in further detail on the notion of systems of innovation and national systems of innovation as well as on the different approaches towards these theories. Seeing the process of innovation as not merely the combined output of science and R&D efforts, systems of innovation and national systems of innovation theory emphasizes the importance of learning as a whole, taking into consideration the crucial role which production and consumption hold in driving innovation (Lundvall 2010, 10). Although educational and R&D efforts do contribute to a big portion of what is being innovated, innovation can also be the product of other types of learning processes that are part of regular economic activities (Edquist 2005, 16). These learning processes, which are not based on scientific discovery, can be described as learning by doing, learning by using, and learning by interacting (Chaminade & Lundvall 2019, 6).

Identifying it as an extension of systems-oriented theory, Edquist and Hommen point out a focus on learning processes, the adoption of interdisciplinary and holistic perspectives, the employment of historical perspectives, emphasis on non-linearity and interdependence, a focus on

the central role of institutions, and the incorporation of organizational innovation and product technology as characteristics of the systems of innovation approach (Edquist & Hommen 1999, 65-6). In addition, systems of innovation approaches are argued to focus on system difference rather than optimality, to be associated with conceptual diffuseness, and to be conceptual frameworks rather than formal theories (Edquist & Hommen 1999, 65-6). Due to their interactive nature, learning processes are taking place between as well as within organizations and require continuous interaction and collaboration between stakeholders (Chaminade & Lundvall 2019, 7-8). As far as technology transfer goes, in this case referring to the exchange of information and knowledge between organizations (Bozeman 2000, 629), different types of policies have been identified, ranging from approaches based on free market mechanisms to models based on the notion of cooperation between universities, industry, and government (Bozeman 2000, 632). Bozeman also points out that, although similar in many ways, universities and government laboratories differ from each other, as a university's output is greatly influenced by the presence of students, while government laboratories possess a comparative advantage due to their interdisciplinarity in team organization and their often superior scientific facilities (Bozeman 2000, 635-6). In his considerations regarding the systems of innovation approach, Edquist states that "innovations are not only determined by the elements of the system but also by the relations between these" (Edquist 2005, 21), which are processes he describes as interdependent and non-linear (Edquist 2006, 186). As a means to further deepen the understanding of national systems of innovation frameworks, a division into "core" and "wider setting" has been proposed, core being the interaction between firms and the knowledge infrastructure, while wider settings include national education systems, financial and labor markets, competition, welfare regimes, as well as intellectual property rights (Lundvall 2007, 102).

The differences between science, technology, and innovation policies are described as follows: Science policies can be understood as state efforts aiming at the distribution and allocation of resources to universities, technological institutes, R&D laboratories, and research institutions, as well as the establishment of mechanisms linking them to governmental and industry research users, including resource allocation, incentivization models, and tax relief and subsidy schemes (Lundvall & Borrás 2005, 605-7). Stating that although universities are, for the majority of nations, the main contributors to public R&D and are as such funded through block grants and direct funding measures, Edquist points out the importance of looking at the overall setup of public research institutions within a given national system and at the role which non-university public research organizations and private organizations may play in producing

publicly available knowledge (Edquist 2006, 193-4). Although the actors of innovation remain the same entities, technology policy on the other hand has a more instrumental aim, focusing on specific technologies, strategic sectors, and economic objectives, which can be promoted by means of instruments such as public procurement or direct incentives like subsidies and tax reductions (Lundvall & Borrás 2005, 608-10). As policy approaches in the real world can hardly be grouped as being either completely science- or technology-focused, innovation policy looks at all segments within the economy which affect innovation processes, understanding innovation as a more complex process and taking into consideration organizational and institutional aspects of innovation structures, including considerations regarding the importance of competition, access to venture capital, and the regulation of intellectual property rights (Lundvall & Borrás 2005, 611-14). Regarding the role of institutions, Lundvall and Borrás point out that "[o]ne fundamental distinction in innovation policy goes between initiatives aiming at promoting innovation within the institutional context and, respectively, policies aiming at changing the institutional context in order to promote innovation" (Lundvall & Borrás 2005, 612-3). Science, technology, and innovation policy has also been described as "government intervention in the economy to support scientific discoveries and the development of technological solutions" (Chaminade & Lundvall 2019, 1).

Arguing that the process of innovation is in many instances driven by the network of interrelations between individual organizations, Edquist points out the importance of institutions in facilitating innovation in the form of laws, technical standards, health regulations, as well as social and cultural norms (Edquist 2005, 2). Different types of policy instruments have been categorized into regulatory, economic, and soft measures (Borrás & Edquist 2013, 1516). Specific measures mentioned are public support for research organizations, adjusting their governance and statutes, competitive research funding, employment regulations of researchers, contractual agreements with public research organizations, tax exemptions, support through venture and seed capital, competition and antitrust policy, intellectual property rights, public-private partnerships through public enterprise, public campaigns and communication through events or media, ethical regulations, as well as soft rules such as voluntary technical standards or codes of conduct (CoCs) (Borrás & Edquist 2013, 1516-8). Paic and Viros classify the instruments utilized to further science and innovation efforts as direct and indirect financial support, infrastructures and collaborative platforms, and regulatory measures (Paic & Viros 2019, 23). While direct financial support is defined as any form of direct financial aid for research institutions, typically either performance-based, long-term, or competitive project-based

financing schemes, indirect financial support can be provided to private sector firms through policy tools such as tax credits, loans, credit guarantees, or equity investment (Paic & Viros 2019, 23-4). Collaborative platforms and infrastructures, on the other hand, can be understood as efforts to create networks that connect private enterprises and public research, training and support services, the funding of competitiveness centers, as well as the establishment of public markets that support innovation by stimulating demand (Paic & Viros 2019, 23-5). Lastly, the aspect of regulatory instruments covers the adjustments of existing laws, standards, and other criteria in order to support and facilitate innovation, also including considerations regarding intellectual property rights (Paic & Viros 2019, 24). When examining the specific activities within those categories, it has been pointed out that a distinction between supply-side and demand-side measures can be made, and, although real world policy strategies have thus far tended to focus on the former, a recent focus on demand-side activities can be identified, aiming at solving societal issues centering around topics such as global change, resource supply or public health (Borrás & Edquist 2013, 1519). It has further been stated that linear approaches towards innovation policy are focused on supply-side-oriented strategies, while systems-oriented approaches tend to pay more attention to the demand-side, both theoretically as well as in terms of policy relevance (Edquist & Hommen 1999, 64).

Understanding the interconnection between science, technology, and the economy, as well as understanding demand and how to coordinate policies effectively are crucial factors in designing innovation policy (Lundvall & Borrás 2005, 617-23). Taking considerations regarding the demand-side in innovation policy analysis further, Wouter Boon and Jakob Edler bring attention to the factor of needs, stating that demand can be differentiated into the definition of user needs, as well as to the overcoming of societal challenges (Boon & Edler 2018, 436-8). The role of the government in articulating demand within innovation policy by clarifying existing needs and defining challenges is pointed out both within existing innovation as well as in innovation that is still to emerge (Boon & Edler 2018, 437-8). Demand-side measures mentioned to enable the uptake of existing innovation by users are the adjustment of standardization, regulation, training, as well as improving the interaction between users and producers, while defining challenges can be facilitated by means of organized discourse, interlinking with emerging markets, supporting complementary technology, and overall involvement of relevant actors (Boon & Edler 2018, 438). In order to better understand innovation policies from a demand perspective, the authors conceptualize their analytical framework around the criteria legitimacy of input and output, by which they mean normative considerations with regard to

societal needs and in what manner they need to be addressed, as well as the criterion operational intelligence, which they understand as the information required to design and implement policies (Boon & Edler 2018, 438-9). Using these three criteria to analyze policy approaches which are either purely demand-side-focused, sector-specific, or mission- and challenge-oriented, the authors find that potential tensions can arise between those policy types, and that besides defining the concrete demand issue, other conditions necessary for enabling innovation, such as networks and infrastructures, as well as the supply-side's capabilities need to be taken into consideration (Boon & Edler 2018, 439-44). Another important factor for understanding those interconnections better is that of building competence by improving human capital through education and training of skilled personnel in schools and universities as well as throughout working life in the form of apprenticeships, on-the-job training, or simply learning by doing (Edquist 2006, 195-6). Defining competences "as the set of knowledge, skills and expertise that individuals and organizations have" (Borrás & Edquist 2015, 217), Borrás and Edquist describe competence building as the process of either formal or informal acquisition and development of competences by both individuals and organizations (Borrás & Edquist 2015, 217). While internal competences can be understood as either those of a firm's human capital as well as its internal structural assets, such as information and procedures (Borrás & Edquist 2015, 217), external competences are owned by actors outside the individual firm and can be acquired by interacting externally through university-industry relation aiming at HR development, lead users, and crowdsourcing (Borrás & Edquist 2015, 219-20). According to the authors, public policy can address the issue of competence building in three areas: Firstly, by funding, regulating, and organizing the system of both private and public primary to tertiary education (Borrás & Edquist 2015, 220). Secondly, by supporting vocational training systems and incentivizing its schemes (Borrás & Edquist 2015, 220). Thirdly, by adjusting migration policies, including immigration policy and reverse brain drain measures (Borrás & Edquist 2015, 220), by regulating the access of foreign HR to the domestic labor market (Borrás & Edquist 2015, 222). Concludingly, Borrás and Edquist identify the retention, creation, attraction, as well as the identification of the necessary kinds of competences as the main areas within which tensions and deficiencies in a given system can occur (Borrás & Edquist 2015, 224), and state that "[k]eeping a sound balance between internal and external competences is crucial for innovation policy-makers" (Borrás & Edquist 2015, 225).

The systems of innovation approach has been described as interdisciplinary and holistic as it, rather than simply focusing on resource input into science and R&D, acknowledges both

actors and structural frameworks as well as the influence learning processes outside the formal institutions have on innovation (Edquist 2005, 17-8). Already early on, policy frameworks to diffuse technology use have been dubbed as incremental, since the determinants of improving product quality and productivity have been identified as "not the rate of development of new technologies but the speed and extent of their application in commercial operations" (Stoneman & David 1986, 142). Public policy facilitating technology diffusion, specifically by "creating an infrastructure conducive to a rapid spread of awareness and knowledge of innovations" (Stoneman & Diederen 1994, 918), aims at helping actors to overcome the issue of imperfect information, enabling adapters to acquire information directly rather than doing so passively by observing the experiences of others, or having to actively conduct new searches (Stoneman & Diederen 1994, 920-1). The two main means for policymakers to facilitate this have been described as information provision policies on the one hand and provision of subsidies to technology users on the other hand (Stoneman & David 1986, 142). Imposing technical standards is stated as another option for policymakers to promote diffusion by decreasing information uncertainty within the market, making it possible for firms to conduct innovation processes without having to wait for an industry standard to be established by the free market and therewith diminishing the risk of pursuing wrong technological trajectories (Stoneman & Diederen 1994, 922). At the time of observation, Stoneman and Diederen have identified a policy focus on countering imperfect information and increasing the speed in which information is diffused, specifically targeted towards small and medium-sized enterprises (SMEs) (Stoneman & Diederen 1994, 927).

2.5 National Systems of Innovation: Limitations and Criticism

As this topic has of course been subject to scrutiny, in the following section, I am going to demonstrate the criticism voiced toward national systems of innovation theory and attempt to reflect on the scholarly opinions given in this context. The concept of a national system itself, and whether it can be clearly defined, has been brought up, specifically pointing out the degree of national, linguistic, and ethical homogeneity on the one hand and that of political centralization on the other hand (Lundvall 2010, 2-3). Besides the national level, other levels on which systems of innovation and their policy frameworks can be analyzed are the supranational, regional, and sectoral spheres as well as specific fields of technology (Edquist 2005, 11). It has been argued that due to the increasing importance of interrelations between sectors as well as regions in furthering the process of innovation, frameworks around those aspects will gain

importance, while national innovation systems frameworks will gradually lose relevance (Balzat & Hanusch 2004, 206).

Recognizing the increasing importance of the transnational character of the innovation process, specifically cross-national interrelations between big corporations, areas such as international trade, industry specialization, and foreign direct investment have been pointed out as influential factors in the increasing internationalization of innovation (Lundvall 2010, 16-17). In the face of the markets' expanding dimensions, strategies by state as well as private actors have shifted away from a solely single state focus (Archibugi & Michie 1997, 124), making it crucial that "various aspects of National systems of innovation need to be considered within the context of increasing international integration" (Archibugi & Michie 1997, 128). A shift to a supranational analysis approach has also been suggested in the case of growing institutional compliance between countries, such as in the case of the European Union, given that the degree of national self-determination of the member states regarding innovation policy should decrease (Balzat & Hanusch 2004, 206). In the face of globalization, the influence of innovation efforts on a national level has been argued to decrease due to the divergence of interest between private firms and their nations of origin (Lundvall 2016, 362). However, it has also been stated that their role in representing political agency might actually increase their leverage (Lundvall 2016, 362). A focus on systems of innovation on a global level, more specifically from the viewpoint of global value chains, has been criticized for examining innovation on either firm level, cluster based, or for looking at the value chains themselves, rather than on the aggregate level, as it has been suggested by the national systems of innovation approach (Lundvall 2016, 366). Archibugi and Iammarino have examined how globalization influences national innovation by looking at the role which public policy assumes in this concern, specifically analyzing the three sectors of international exploitation and global generation of innovation as well as global innovation collaboration (Archibugi & Iammarino 1999, 242-3). The overall improvement of R&D and basic research structures as well as improved competition regulations have been identified as a means for government policy to address international exploitation (Archibugi & Iammarino 1999, 261), while global innovation generation can be influenced by policies protecting technologically valuable firms from foreign acquisition, stimulating high value added activities locally, and at the same time preventing technological imbalances between firms on a national level (Archibugi & Iammarino 1999, 262-3). Global innovation collaboration, finally, can be supported by enabling innovation by means of the establishment of international organizations and agreements between governments as well as through policy

frameworks which incentivize collaboration by improving national innovation infrastructure (Archibugi & Iammarino 1999, 264). The authors conclude that, rather than rendering it outdated, all three viewpoints suggest that public policy efforts should be expanded in order to optimize national benefits in a globalizing innovation environment (Archibugi & Iammarino 1999, 266). Identifying public support for basic research, a certain orientation of workforce skills, business-funded R&D, systems of finance and management, competitive rivalry, as well as inducement mechanisms and sectoral technological advantage as the key features and main areas of strengths and weaknesses of any given national system of innovation (Pavitt & Patel 1999, 100-8), Pavitt and Patel find that technological competitiveness of private firms is directly dependent on national systems of innovation, which in turn are dependent on public policy (Pavitt & Patel 1999, 110). The authors go even further and state that they do not see this as very likely to change in the future, concluding that they neither see a strong trend towards the globalization of private innovation activities nor towards the convergence of national systems of innovation (Pavitt & Patel 1999, 111-4).

Contrary to looking at systems of innovation on a wider, trans-national scope, the importance of considering their regional differences has also been pointed out, specifically concerning the issue of some regions' greater need for innovation promotion due to their relative underdevelopment and the tendency for governments to apply industrial policy to lagging regions, while technology policy appears to be directed at already advanced regions (Oughton et al 2002, 98). It has been argued that all key factors highlighted in systems of innovation theory, such as learning, the relationship between firms, and institutional frameworks, also vary across regions, and evidence that differences in R&D and education expenditure tends to be bigger between regions than it is between nations has been presented (Oughton et al 2002, 99). Besides this uneven concentration of R&D efforts, knowledge spillover effects tend to be limited to a certain distance from industrial clusters (Tödtling & Trippl 2005, 1207-8), and aspects that are vital to understanding systems of innovation, namely learning processes, institutional innovation, and the formulation of an overall innovation demand, have been suggested as factors that differ substantially between regions within the same national system (Oughton et al 2002, 102). Policy fields can be viewed from the perspective of infrastructural issues, such as taxation and financing, as well as superstructural issues, such as level of cooperation and networking (Cooke 2001, 958-61). Therefore, in addition to having a clear definition of a region's innovation policy capacities, regional budgets, infrastructure financing, institutional learning, as well as fostering a culture of cooperation have been deemed as key areas via which regional innovation

systems can be enhanced (Cooke et al. 1997, 479-89). Although Cooke agrees with the notion of interactive learning as proposed in national innovation systems theory, the broad nature of national innovation systems approaches and their disregard for the regional aspect of innovation has been criticized (Cooke 2001, 952). As far as real-world policies go, issues identified as being specifically challenging for the advancement of regional innovation systems are the shift from a firm-centered to a system-focused policy approach, more focus on institutional and organizational aspects besides R&D, stronger networks between policymakers, competitive bidding systems between regions, and an overall better coordination with the political system (Tödtling & Trippl 2005, 1211-2). Cooke et al. point out that, when looking at government policies directed at furthering innovation, it is important to keep in mind that even within a given national state, distinctions between regions of that same national system need to be taken into consideration (Cooke et al. 1997, 479).

In his early contributions to the examination of industry sectors on innovation processes, Keith Pavitt identifies three factors which technological advancement depends on in a market framework: the sources of technology, which can be understood as any form of knowledge input, the users' needs, as well as the means utilized to appropriate benefits gained by means of successful innovation, usually through protection of new innovations (Pavitt 1984, 355). These characteristics can be used to interpret the technological trajectories of innovating firms, which Pavitt categorizes into supplier dominated, production intensive, and science-based enterprises (Pavitt 1984, 353). Stefano Breschi and Franco Malerba emphasize the concept of technological systems in their research on sectoral innovation systems, which are specific to technology in a distinct industrial field and according to which knowledge flows as well as the creation of new technologies are taking place among certain groups of firms or industries (Breschi & Malerba 2005, 130). In this context, technological regimes are described by the authors as the most influential factors of innovation within a given market, the nature of which is a combination of the factors opportunity conditions, which reflect the probability of innovation through investment into searching, appropriability conditions, which can be seen as the possibilities to avoid imitation, the cumulativeness of knowledge, as well as the attributes of the respective knowledge base (Breschi & Malerba 2005, 133-7). The advantages of taking sectoral alongside national perspectives into consideration when analyzing systems of innovation are pointed out by Herbert Kitschelt, stating that specific industrial sectors will only operate efficiently if policy frameworks match their technological requirements (Kitschelt 1991, 468). While the author concludes that analyses on a solely national level "do not supply the

conceptual framework to account for sectoral variations of industrial strategy" (Kitschelt 1991, 491), he does admit that sectoral approaches do have certain limitations, specifically their inability to explain technology choice in certain countries or regions as well as the fact that learning processes must be studied from a wider, regional or national, viewpoint (Kitschelt 1991, 468). The aspect of sector is also taken into consideration in the conceptual framework for conducting cross-country systems of innovation analysis proposed by Markus Balzat and Andreas Pyka, to which, besides the usual components of national innovation systems analysis, the criterion of sectoral specifics is added (Balzat & Pyka 2005, 7). Stating that the addition of sector as a parameter allows for a better understanding of interdependences between industrial and institutional structures (Balzat & Pyka 2005, 7), the authors find that including sectoral considerations into national innovation systems analysis models helps to obtain a more comprehensive understanding of the state of a given system of innovation, which is particularly due to the uneven distribution of innovation activities among the various industry sectors (Balzat & Pyka 2005, 16).

2.6 Cross-Country Innovation Policy Analyses

Having provided insight into systems of innovation theory and the discussion surrounding the national systems of innovation approach, in the following section, I am going to shed some light on how public innovation policy frameworks have been analyzed and compared on a cross-country basis, and how national systems of innovation approaches have been applied to do so. The circumstances in which countries' underlying conditions for innovation can differ are manifold: national production structures, availability of resources, legal frameworks and regulations, as well as cultural values and many other factors come into play, all of which shape the composition of each respective national system in their own individual way (Edquist 2005, 19-20). Comparing the resulting national differences, which is emphasized in the systems of innovation approach, has been pointed out as crucial in understanding and being able to reflect on given national systems of innovation (Edquist 2005, 20) – a notion which has already been touched upon in the previous chapter of this paper.

As already mentioned in previous sections, cross-country comparisons based on public funding and spending do exist in a relatively large number, and although research in that field does not specifically look at their composition, relevant policy areas have been pointed out: Christian Rammer mentions the fields of public R&D financing, public support for private R&D, public support for innovative SMEs and start-ups, reform of public research

organizations, as well as promotion of technology transfers as measures to investigate when conducting a cross-country comparison of innovation policies (Rammer 2006, 268). While also taking into consideration the influence which international policies, namely those of the EU, have (Rammer 2006, 282-4), Rammer identifies a correspondence of those overall innovation policy priorities among all examined national economies by comparing several country cases (Rammer 2006, 284-5). Similarly, although focusing on performance aspects as well as structural aspects, Balzat and Pyka state the intent to apply their analytical framework in order to shed light on the similarities and differences of innovation activities on a cross-national level (Balzat & Pyka 2005, 8), concluding that "international comparisons and especially classifications of national innovation systems are important extensions" (Balzat & Pyka 2005, 17) to the national innovation systems concept (Balzat & Pyka 2005, 17).

An extensive cross-national analysis based on the national systems of innovation approach is provided by Richard Nelson, comparing a total of 15 countries with a specific focus on the interconnection of science and technology as well as the role which institutional actors play in technological advance within the respective national systems (Nelson 1993, 3-15). The author directs his attention towards the question to what extent national and technological communities do exist, and how, despite the trend of internationalization, similarities and differences in national systems of innovation can be detected (Nelson 1993, 15-8). In this edited issue, the authors of each specific country case examine a set of given features, such as R&D allocation and funding, the role of universities, and how public policy is generally directed at driving innovation, and emphasis is put on specifying the most defining features of each national system as well as using those as a reference for cross-national comparison (Nelson 1993, 19). Grouping the examined national systems into large high-income countries, small high-income countries, and lower-income countries (Nelson 1993, 19), Nelson finds that education is conducted publicly across all examined countries, and although the measures and ways in which it is funded differ from each other, all governments examined take a high degree of responsibility for supporting basic and applied research (Nelson 1993, 506-7). Differences in innovation policymaking among the groups have been identified as connected to considerations regarding comparative advantage, issues regarding natural resources and reliance on imports, the significance of national security, and general beliefs regarding the role government should play in technological development (Nelson 1993, 507-8). The level of public policy degree regarding the support of high-tech industry R&D has been identified as very uneven among the country cases observed, with a trend towards declining government protectionism as firms become

more successful (Nelson 1993, 517). Reflecting on the national systems of innovation approach overall, Nelson concludes that, despite increasing nationalization, big parts of the frameworks for innovation are still molded around nationally shared culture and historical experience (Nelson 1993, 518). However, within a national system itself, sectoral differences need to be taken into consideration when analyzing a nation's systems of innovation framework (Nelson 1993, 518).

Focusing on public policies targeted at stimulating R&D activities, Sunil Mani applies the national systems of innovation approach to a cross-country comparison of developing countries, arguing that besides financial means to promote R&D, non-monetary means are equally important for driving forward a country's R&D efforts, specifically the field of HR development (Mani 2002, 31). While also looking at the general indicators research intensity, patenting numbers, and technology exports (Mani 2002, 33-5), Mani's analytical framework examines national policy approaches by looking at their efforts in the areas tax incentives for R&D, research grants for firms, government-backed venture capital, and non-fiscal instruments (Mani 2002, 36). The author finds that public innovation policies still hold relevance despite a trend of globalization and attributes importance to both financial and non-financial instruments, emphasizing the indispensability of the development of scientifically and technically trained HR, the lack of which is identified as hindering to the improvement of R&D processes in several developing countries analyzed (Mani 2002, 43). Also based on the national systems of innovation approach, Charles Edquist and Leif Hommen conduct a cross-country analysis focusing on a number of small high-income countries in Europe and Asia, all of which were identified as having "established reputations for success within the context of globalization and the advent of a 'new' economy where competition is increasingly based on innovation" (Edquist & Hommen 2008, 12-3). Providing R&D, competence building, financing innovation processes, forming new product markets, articulating demand-side quality requirements, creating and changing organizations, networking across markets, providing incubation activities and consultancy services, and creating and changing institutions, such as patent and tax regulations, safety and environmental regulations, or investment schemes, are identified as key activities in systems of innovation (Edquist & Hommen 2008, 10). The framework proposed to analyze the country cases consists of the criteria knowledge inputs to innovation, demand-side factors, provision of constituents, support services for innovating firms, innovation intensity, as well as consequences of innovations, and, while also taking into consideration the factor of globalization, aims at identifying the strengths and weaknesses of a given national system and its innovation

policies (Edquist & Hommen 2008, 15-9). Discussing the selectivity and coordination of as well as the rationales for innovation policy (Edquist & Hommen 2008, 458-78), Edquist and Hommen find that the propensity to innovate varies among the analyzed countries, and although the importance appointed to innovation policy also differs among them, they all have made statements to pursue future policy design based on the systems of innovation approach (Edquist & Hommen 2008, 478-80). The authors further conclude that innovation policies in place across all countries can largely be identified as selective and with a certain focus on electronics and information technology, and argue that national systems of innovation, due to their recognition of the significance of innovation policy coordination, will remain a central concept in the foreseeable future (Edquist & Hommen 2008, 479-81). In a similar account, Philippe Larédo and Philippe Mustar present a cross-country study on the impact of research and innovation policies, covering a number of countries with different sizes and trajectories (Larédo & Mustar 2001, 4-5). In order to ensure comparability, all country studies were carried out taking into consideration several central questions: education, innovation incentivizing policies, public research facilities, the role of regions, direct public intervention, and the specific technology areas of defense and large-scale civil programs (Larédo & Mustar 2001, 6-9). From the results of the analyses, Larédo and Mustar deduce that innovation policies are considered to play an important role in ensuring firms' international competitiveness, that higher education and public sector research is widely emphasized by policymakers, and that innovation policy has become more cooperative and attentive to regional and sectoral issues over the last decades (Larédo & Mustar 2001, 498-509). Looking specifically at the area of technology diffusion, Rosa Caiazza argues that, besides general economic, legal, cultural, and technical obstacles, there are two general obstacles to innovation diffusion: supply-side barriers, which can be seen as the difficulties innovators face when introducing innovations to the market, as well as demand-side barriers, which are hindering factors to making users aware of new innovations as well as to adopting them (Caiazza 2016, 1409). While the author identifies general diffusion policies as such that aim at facilitating innovation adoption by means of an institutional, regulatory, and economic framework, supply-side diffusion policies are measures that provide innovators with the necessary means and support to overcome resistances in the market and enable them to adapt their technology to the respective market needs (Caiazza 2016, 1411). Measures used to accomplish those aims are centers via which information is provided and technology improvement is promoted, technical and financial support to commercialize innovation, and assistance in internationalizing technologies (Caiazza 2016, 1413). Explaining demand-side policies as instruments that raise demand for certain innovations by improving the

conditions for their adaptation, demand-side related diffusion measures include technical assistance centers, information programs, training, demonstrations, public procurement, and financial support (Caiazza 2016, 1412-3). The author goes on to compare the innovation policies in place across a number of European countries, and by looking at both adoption rates as well as the level of diffusion policies in each respective country, Caiazza finds that, although the reduction of diffusion barriers has been on the agenda for most European policymakers, adoption rates differ heavily between countries (Caiazza 2016, 1413-6). However, higher levels of policy do appear to have a conducive influence on innovation adoption overall (Caiazza 2016, 1413-6). Looking at science, technology and innovation, as well as industrial policy strategies, Sandra Planes-Satorra and Caroline Paunov assess different countries' national innovation policy approaches towards the digital age and the AI transformation (Planes-Satorra & Paunov 2019, 14-27): Tools to support the adoption and diffusion of new technology are identified as strategies that raise awareness and support capacity building, financial support through investment, testing facilities, and provision of technology expertise (Planes-Satorra & Paunov 2019, 28-30). On the other hand, innovation collaboration is shown to be facilitated by founding innovation centers and supporting collaborative research, which can be further enhanced by providing infrastructure such as networks, clusters, crowdsourcing, and living labs (Planes-Satorra & Paunov 2019, 31-5). Additionally, specific support measures directed at furthering innovation of digital technologies are identified as financial incentives directed at specific technologies, enablement of experimentation, as well as efforts aiming at strengthening entrepreneurship by facilitating market entry and providing access to knowledge and finance (Planes-Satorra & Paunov 2019, 36-41). José Guimón and Caroline Paunov similarly provide an overview of policy instruments used to support knowledge transfer and knowledge exchange between academia and industry, grouping them into financial, regulatory, and soft instruments (Guimón & Paunov 2019, 7). While also listing supply-side efforts, such as financial support or training (Guimón & Paunov 2019, 8-9), the authors also state several demand-side oriented strategies: Financial and regulatory demand-side measures include public technology procurement, public-private partnerships and joint research laboratories, ownership of public-private research, innovation vouchers in the form of affordable R&D support, as well as funding of key infrastructure, such as business incubators, science parks, or technology transfer offices (Guimón & Paunov 2019, 8-9). Contrarily, soft demand-side measures, which are usually closely intertwined with supply-side measures, include tools such as awareness-raising, networking support in the form of events and workshops, technology roadmapping efforts, and voluntary collaboration based on pre-set guidelines and standards (Guimón & Paunov 2019, 9).

With the aim of providing a toolkit for public entities that intend to improve their innovation processes (OECD, 2015, 3), in their report *The Innovation Imperative – Contributing to Productivity, Growth and Well-Being*, the Organisation for Economic Co-operation and Development (OECD) highlights the policy areas they have identified as particularly important, namely business environment, knowledge creation and diffusion, workforce, and business incentives (OECD, 2015, 48-9). The OECD highlights the importance of the private sector's investment in knowledge-based capital in the form of R&D, software, data, skills, know-how, intellectual property, and brand equity (OECD, 2015, 71). Besides general taxation frameworks, such as the level of corporate and income taxes (OECD, 2015, 124), growth taxes, or taxes targeting specific externalities, tax support and tax relief aimed specifically at incentivizing R&D activities as well as taxation systems that encourage domestic R&D efforts are mentioned as targeted innovation policy measures (OECD, 2015, 74-5), including taxation schemes that incentivize intellectual property assets such as patents or brands (OECD, 2015, 125-6). The issue of global value chains is pointed out as somewhat similar to that of taxation, as aspects surrounding tariff and non-tariff barriers as well as export restrictions can affect national innovation activities, and improving national policy setup around them can help to increase international competitiveness of domestic firms (OECD, 2015, 82). Innovation policy-specific financing strategies mentioned are such that increase the access to seed and early-stage financing, the provision of risk capital, the possibility for SMEs to publicly list, as well as asset- or debt- and equity-based financing approaches (OECD, 2015, 75-8), pointing out that the aspects of coherence and transparency are important factors in investment-focused innovation policy, and that they should be evaluated regularly (OECD, 2015, 84). Specific approaches to debt and equity finance listed are credit loans, loan guarantees, risk-sharing, advances, repayable grants, mezzanine funding, venture capital, and business angels (OECD, 2015, 124). In order to foster an environment of experimentation and entrepreneurship, the OECD states that encouragement of efficient and dynamic reallocation towards more productive firms, specifically young ones that bring new knowledge to the market, is crucial and analyzes national innovation policy tools based on their capacity to ease market entry by removing entry barriers on the one hand and to facilitate market exit of less productive firms on the other hand (OECD, 2015, 79). As far as the creation and diffusion of knowledge goes, policy trends tend towards initiatives related to financing mechanisms and promoting research on a multidisciplinary level, assessment of research, and spin-offs, commercialization, and centers of excellence (OECD, 2015, 91). Support strategies can be directed at either fundamental core sciences or as having a more competitive approach towards driving innovation, meaning that funds would be distributed by

applying for specific, relatively short-termed, projects (OECD 2015, 91-2). Funds can be allocated towards research itself, recruiting and connecting researchers, investment in their training, as well as physical infrastructure for research, promoting interdisciplinary and international research, and the diffusion of created knowledge (OECD 2015, 92). The means mentioned to allow for the diffusion of knowledge are based on the notion of open science and making scientific data more accessible, in turn generating knowledge spillovers, allowing for the interlinking of research fields, making knowledge more accessible to SMEs, and helping address global challenges (OECD 2015, 94-5). Although public intellectual property is still a crucial means to commercialize public research, the advance of other channels such as contract research, spin-offs, collaborative research, consulting, or student entrepreneurship has made the aspect of technology transfer by means of technology transfer alliances between research organizations, for-profit models, internet platforms, or free agency models a critical aspect in designing innovation policy (OECD 2015, 100-4). Bringing the above areas together, the OECD introduces the concept of knowledge networks and markets, under which they see a compilation of systems, institutions, networks, and infrastructures that allow for the exchange of knowledge by providing the necessary solution sourcing and problem solving platforms, assisting with the transfer of knowledge between people as well as organizations and resolving ownership issues regarding disembodied knowledge (OECD 2015, 115-6), specifically mentioning technology consulting services and extension programs (OECD, 2015, 124). Areas to look out for when assessing knowledge flows are the mobility of skills, the accessibility and openness of knowledge, the transaction of knowledge, knowledge rights, and how knowledge is co-created (OECD 2015, 117). Closely connected to the issue of knowledge diffusion is of course that of human capital and workforce development, as the development of skill within the workforce heightens the rate at which new knowledge is generated and absorbed and also leads to its diffusion by means of interaction and entrepreneurial activity (OECD 2015, 50). As a means of fostering innovation within a national workforce, the OECD suggests the fostering of foundation skills by means of general educational measures such as exposing students to a variety of knowledge by broadening curricula, encouraging creativity and critical thinking, allowing for the development of entrepreneurial and communication skills, focusing on problem-based learning, and utilizing multidisciplinary and interdisciplinary approaches (OECD 2015, 54-6). After initial education, innovation within the labor force can be fostered by making academic careers more attractive by improving material rewards and career opportunities, developing entrepreneurial skills and mindsets within institutions of higher education, supporting lifelong learning by incentivizing participation in job-related and other training activities, and

enabling companies to organize workplace structures in a way that supports internal innovation processes (OECD 2015, 57-60). Additionally, skill mismatch and waste of skill can be reduced by matching workers to their respective jobs more efficiently (OECD 2015, 53), and the OECD also points out the importance of improving women's participation in the innovation process by removing access barriers to both scientific and entrepreneurial roles, as well as that of highly skilled international workers by improving global mobility (OECD 2015, 53). Exploring policy measures on the demand-side, innovation-oriented public procurement, innovation-oriented regulation, and innovation-oriented standards are mentioned as the main innovation policy tools utilized (OECD, 2015, 139). While public procurement strategies aim at creating demand for new technologies and R&D services through financial support to promising enterprises (OECD, 2015, 124), innovation-oriented regulations and standards are based on the premise of setting regulatory conditions and a framework of consent that enhance the demand for innovative goods and services (OECD, 2015, 141-3). The aspect of the consumers' involvement in the innovation process and the way in which policy can shape their demand also needs to be taken into consideration in this regard (OECD, 2015, 144-5). The OECD, too, states that when assessing innovation policy, the aspects of location, clusters, as well as sectoral disparities need to be considered (OECD, 2015, 129-33) alongside the role of business accelerators as a policy tool to support firms in closing existing gaps (OECD, 2015, 134). Policy approaches targeted at certain industries and such that support specialization also fall into this category (OECD, 2015, 137-9), as opposed to generic approaches that are not targeted at specific technologies (OECD, 2015, 148).

Besides the mentioned general cross-national analyses of innovation policy measures, some contributions made by different authors have shed light on technology-specific policy approaches. Based on the contributions to the analysis of innovation policy by Rothwell and Zegveld, which have been touched upon in a previous section, Joseph Shyu et al. set out to conduct a comparative cross-country analysis, classing policy instruments into supply-side, demand-side, as well as environmental ones, by which they mean measures establishing the regulatory and financial framework in which innovation can take place (Shyu et al. 2001, 229-32). Examining the integrated circuit industries within Korea, Taiwan, the People's Republic of China, and the US, Shyu et al. compare the policy tools used and, aiming at better understanding competitiveness of industry innovation requirements, investigate the policy focus of the respective countries by dividing it into the areas R&D, technical knowledge, R&D environment, management skill, manpower, financial resources, market information, domestic market, and

international market (Shyu et al. 2001, 232-6). Shyu et al. find that while all countries analyzed made use of similar technical, scientific, and legal measures, country specific policy foci could also be identified: Policymakers in the US were focusing on procurement, Korean efforts were emphasizing taxation and finance, in Taiwan, political tools and provision of public research were prevalent, and in mainland China, commercial tools were introduced as a central policy measure (Shyu et al. 2001, 236-9). The authors conclude that most of the policy approaches analyzed have been beneficial for technology development (Shyu et al. 2001, 239). However, their effectiveness to improve market opportunities was lacking, and, as far as relative competitiveness of industry innovation requirements go, the US had a competitive advantage over the other nations at the time of analysis (Shyu et al. 2001, 239). Based on the groundwork provided by Rothwell and Zegveld as well as Shyu et al., Chen-Chun Lin et al. attempt to examine the development of smart grid policy by utilizing a similar analytical approach which also groups policy tools into demand-side, supply-side, and environmental measures (Lin et al. 2013, 120-3). Supply-side instruments include measures such as public research, public education, and public enterprise, while the environmental side is described as including measures like access to finance, regulatory adjustments, and taxation benefits (Lin et al. 2013, 123). Besides the adjustment of tariffs, trade agreements, currency regulation, and overseas agents, demand-side tools include public procurement measures, such as government contracts and purchases, public enterprise, R&D contracts, or prototype purchasing, as well as public services, which can be understood as the acquisition, supervision, innovation, and maintenance of fields such as telecommunications, transport, public building, construction, or health services (Lin et al. 2013, 123). By sourcing large amounts of data from both primary and secondary sources, the authors conduct a survey on the smart grid policy measures of China and the US, aiming to allocate their focus within a given range of criteria, such as scientific, public services, and legal policy efforts (Lin et al. 2013, 123-5). While efforts relating to scientific advance and technological development are dubbed as most influential, the authors identify a focus on supply-side measures by China, while the US exhibit a dependence on environmental policies (Lin et al. 2013, 126). They further conclude that, within the realm of smart grid, the relatively low number of demand-side policies suggests that the technology is still at an early level of development, and that regulatory and legal policy is primarily aiming at establishing industry standards (Lin et al. 2013, 126-8).

2.7 Fourth Industrial Revolution Innovation Policy Analysis

In this section, I am going to attempt to provide an overview of the scholarly contributions to the analysis of public policy targeted specifically at supporting the innovation of FRI technologies and processes. As already touched upon in the introductory chapter, Georg Reischauer sees the core identity of Industry 4.0 as a policy-driven innovation discourse, with the intended outcome of a system of innovation that incorporates business, academia, and politics (Reischauer 2018, 28). Arguing that the ultimate aim of Industry 4.0 is the institutionalization of this intended outcome and making it persistent over time (Reischauer 2018, 29), the author finds that the intricacies of FIR innovation policymaking can be best analyzed by taking an innovation-discursive point of view (Reischauer 2018, 31). Since the impact of Industry 4.0 on business, the economy, and society overall is currently difficult to assess, Reischauer suggests that a focus on the current discourse centering around the topic, such as specific strategies chosen by countries to approach the FRI, might be the most productive approach at this point in time (Reischauer 2018, 31-2).

Seeing as FIR innovations are projected to produce enterprises with substantial scale and considering that the ease of market entry by new firms will be enhanced due to the quickly improving and disruptive nature of the newly emerging technologies, James Speta proposes to consider policy in this area as a facilitator and regulator to market entry (Speta 2017, 8-12). Stating antitrust regulation as a crucial tool of competition policy in this regard, the author mentions cartelization, vertical restrictions, as well as merger regulation as areas that are specifically relevant for enabling innovation in the FIR (Speta 2017, 15-8). As far as the role of economic regulation goes, market entry can be promoted by ensuring interlinking to established monopoly, supporting market-based mechanisms, and subsidizing infrastructure, while also making sure that matters regarding health and safety are regulated separately (Speta 2017, 21-6). Furthermore, an important role is assigned to education, specifically the fostering of entrepreneurship and problem-solving skills, emphasizing the importance of a humanitarian education, technical literacy, and lifelong learning (Speta 2017, 26-8), and research funding is identified as a tool that enables policymakers to address topics concerning the possibility to better monetize public research by closing the gap between basic and applied research (Speta 2017, 28-9). Speta concludes that public regulatory frameworks can act as a means of enabling innovation to develop freely rather than giving it a certain direction, while research and educational measures support its diffusion and incentivize the active participation of all stakeholders (Speta 2017, 29). Besides the more general measures of increasing capital fluidity, strengthening

institutions and systems, increasing wages, and adjusting taxation structures designed to respond to the FIR (Lee et al. 2018, 7-8), Lee et al. propose that their ability to deal with the FIR's knowledge-based and highly disruptive nature is key in the assessment of innovation policies, identifying openness, flexibility, and orientation towards the future as integral aspects to take into consideration when breaking down public policy in this regard (Lee et al. 2018, 9). Lee et al. point out certain areas to be addressed by countries, such as the integration of R&D into industry and the linkages between industry and academia, standardization measures, talent development and training, and smart industrial supply chains (Lee et al. 2018, 10). The authors conclude that the capacity of economic policy to enable creativity of firms as well as the institutional setup supporting the exchange between science, research, businesses, and the public should be taken into consideration when analyzing innovation policy frameworks (Lee et al. 2018, 22). In an attempt to shed some light on the social aspect of innovation policy in Industry 4.0, Daniel Buhr argues that, besides focusing on the advancement of technology itself, innovation policy should be considered as a means to support interactive, collaborative systems and to change social innovation and social progress (Buhr 2015, 11-2). Identifying policy coordination and the capacity of existing frameworks to recognize innovation in a wider sense, acknowledging both technological and social aspects, as important factors in understanding innovation policy compositions (Buhr 2015, 13-4), Buhr states that, in order to grasp the full extent of Industry 4.0 innovation policy, social as well as technical aspects on both the supply and demand-side must be taken into consideration and that a systemic conception of innovation policy would dictate that technological innovation leads to societal progress (Buhr 2015, 15).

In an attempt to better understand the impact of the FIR on a cross-national level, Liao et al. set out to conduct a systematic literature review on academic contributions, with the goal of establishing what the most influential innovation policies related to the FIR are and which similarities and differences can be identified between them (Liao et al. 2018, 1-2). Identifying a total of 18 government plans directly targeting the FIR across the globe (Liao et al. 2018, 5), the authors go on to compare those national innovation policy frameworks based on their duration, main objectives, means of public funding, targeted areas of action, emphasized manufacturing sectors, and prioritized technologies (Liao et al. 2018, 7-13). Liao et al. find that innovation policy areas similar across all countries analyzed can be identified as research and innovation, work, education and training, as well as infrastructure modernization and that a similar sectoral focus on manufacturing and specific technologies, such as robotics and IoT, can also be seen (Liao et al. 2018, 16). Concluding that national FIR innovation policy

frameworks do, however, differ in the degree to which they address the development of production management systems, the authors state that this can be anticipated as the next level of development within the FIR (Liao et al. 2018, 17). While also reviewing general innovation support measures towards the private sector and the development of strategic industries (Hutschenreiter et al. 2019, 10-21), Gernot Hutschenreiter, Johannes Weber, and Christian Rammer look at approaches specifically targeted towards the FIR: Analyzing the FIR strategies of a number of country cases, the authors identify improvement of digitalization opportunities through adjustments of research and regulatory frameworks, focus on skill bottlenecks, as well as stimulation by means of dedicated investment as key aims pursued by all national systems observed (Hutschenreiter et al. 2019, 23-4). Although the specific challenges met as well as the monitoring tools utilized differ among the analyzed countries, the issues targeted, such as R&D investment and skill development, are similar, and a focus is put on the importance of governance in aligning and connecting private and public technology sectors (Hutschenreiter et al. 2019, 25-7). Again based around the framework proposed by Rothwell and Zegveld, Lin et al. have conducted a cross-country analysis of the Industry 4.0 innovation policies of China and Taiwan, making use of a content analysis approach with the aim of providing details on the countries' policy landscapes as well as ranking their respective innovation policy priorities (Lin et al. 2017, 8). Using data collected from official reports and documents, journals, interviews, historical documents, newspaper articles, diplomatic messages, as well as observations and descriptions, the authors briefly outline and classify the overall policy instruments used by the two countries and compare them by contrasting the total numbers of policy tools used by China and Taiwan in each innovation policy field (Lin et al. 2017, 8-12). Lin et al. state that there is a tendency by both countries towards emphasizing environmental-side policies, public services, and education, and while Chinese policymakers put less focus on taxation and financial tools, Taiwanese authorities have directed fewer efforts towards instruments that improve information and procurement processes (Lin et al. 2017, 13).

2.8 Summary: State of the Art

Interest in the role of public innovation policy started to increase in the 1970s due to its impact on areas such as the nuclear, defense, and space sectors and was specifically directed towards the areas of public R&D and the role of consumers in the innovation process. First analytical approaches analyzing the means of government intervention were looking at aspects such as regulations and laws, subsidies, demand, infrastructure, and taxation. Systems of

innovation theory was first introduced in the mid-1980s, based on the concept of science not being produced exclusively by public research organizations but also by private firms engaging in research. The principles of systems of innovation theory evolve around the notion of interactive learning, the importance of institutions, the interaction between public and private creation of knowledge, a science-based industry approach, as well as evolutionary theory. Shortly thereafter, the idea of a national system of innovation was first mentioned, looking at systems of innovation within the scope of national systems and allowing for comparison thereof.

In addition to R&D and educational measures, systems of innovation and national systems of innovation theory put emphasis on the role of learning processes, which comprise learning by doing, learning by using and learning by interacting, and therewith also take into consideration the impact of production and consumption on innovation. Such processes require collaboration and interaction between agents and take place within as well as between organizations. Being a systems-oriented approach, systems of innovation theory, besides the already mentioned characteristics, emphasizes interdisciplinarity, historical and holistic perspectives, nonlinearity and interdependence, and system difference rather than optimality. It can thus be described as a conceptual theory rather than a formal one and conceptually diffuse in nature. According to the science, technology, and innovation policy framework, state intervention can be carried out through either science policy, which supports universities and R&D laboratories, technology policy with a focus on specific technologies or sectors, or innovation policy, which takes into consideration all segments within the economy affecting the process of innovation including institutional aspects. Policy measures identified in the literature are manifold and include areas such as adjustments of regulation and institutions, financial support, interconnecting organizations, information diffusion, competence building, as well as demand-side measures.

Criticism towards the national systems of innovation approach has been brought forth, questioning the relevance of the national aspect over supranational, regional, sectoral, or technology specific levels. Increasing the internationalization and globalization of the innovation processes by means of a shift of public and private strategies away from a single state focus is argued as decreasing the influence of innovation efforts targeted at the national level. On the other end of the spectrum, differences between regions in terms of institutional setup and learning processes within a national system have also been stated to be disregarded by national systems of innovation theory. Furthermore, due to the concept of technology regimes and the notion of technology creation taking place between certain groups of industries or firms, research

attention has been directed towards the sectoral sphere, which also has been argued to be insufficiently included in national systems of innovation theory. According to the literature analyzed, a tendency towards globalization of private innovation activities or the convergence of national systems of innovation is, however, not to be expected, and while regional approaches seem to be lacking in including wider institutional frameworks, sectoral strategies struggle to fully explain and utilize the aspect of broader learning processes. Therefore, in order to make it more comprehensive, it has been suggested to implement and include considerations regarding the improvement of global competitiveness as well as the regional and sectoral spheres into the national systems of innovation framework.

Comparing different national systems of innovation with one another by looking at their respective strengths and weaknesses has been pointed out as essential when attempting to fully understand any given national system's capacity for innovation. A wide array of criteria to assess innovation efforts of national systems has been utilized by researchers, including policy areas such as public research and education, access to R&D, public financing, knowledge diffusion, provision of funding mechanisms, capacity and human capital development, tax environment, consulting services, investment regulations, forming of product markets, collaboration enablement, testing facilities, standard-setting, patent regulations, or consumer involvement. While some publications have put emphasis on the aspect of transnationality of innovation efforts, regional or sectoral levels as well as certain technologies have been analyzed in more detail by others. Furthermore, distinctions between the supply-side and the demand-side have been drawn, and measures concerning the latter have received particular attention. Although a certain focus on performance-oriented indicators is noticeable within the field of research, a variety of publications has assessed the structural aspects of innovation policy regimes and utilized them as criteria in their analysis of the respective national systems of innovation.

As far as the research on innovation policy targeted at supporting the development of technologies and processes related to the FIR goes, the significance of a policy-based discourse on innovation has been pointed out. Surrounding the notion of a system of innovation that consolidates business, political, and academic aspects, policymaking aims at enabling innovation to develop freely and support stakeholder participation and its diffusion by means of public research and education. Specific policy areas identified to reach this aim include education and learning processes, research funding, interlinking industry with R&D and academia, investment schemes, tax adjustments, antitrust regulation, improvement of infrastructure, training and workforce improvement, as well as the overall strengthening of institutions. Besides those

areas, comparisons on a cross-national level have taken into consideration parameters such as emphasized sectors or technologies, means of skill development, public services provision, and procurement, with a focus on technologies specific to the FIR. As the impact of the government measures taken is difficult to analyze at this point in time, it has been suggested to focus research on policy approaches chosen by governments and the discourse surrounding those strategies. It has further been suggested to consider the flexibility of policy frameworks and their orientation towards the future, their technical as well as social aspects on both the supply-side and the demand-side, and to acknowledge both technological and social aspects of strategies in place.

3. Analytical Framework

3.1 Outline: Analytical Framework

This chapter is going to elaborate on the analytical approach chosen for this thesis and provide an explanation of the specific analytical criteria selected. Based on the assessment of the state of the art conducted in the previous chapter, I have identified the main areas discussed in the literature and the parameters deemed most critical for analyzing innovation policy systems by eminent scholars. The analytical framework proposed has been developed around those parameters and is therewith going to be taking into consideration the main discourses and the major issues raised and discussed in a scientific context. Attempting to include all parts of the economy impacting the process of innovation (Lundvall & Borrás 2005, 614), the aim of conceptualizing this qualitative and comparative approach is to allow for the understanding of the exact and complete set of policy tools utilized by a government on the one hand and to make possible a cross-national comparison of innovation policy regimes. By compiling a comprehensive catalogue of potential public policy instruments, this framework will enable me to assert which exact policy choices have been made by Japan and Korea, while also highlighting which policy strategies have not been chosen by their respective governments.

The following policy areas have been chosen to base this framework on: The section *Knowledge Creation, Information Diffusion, and Skills* is going to be elaborating on the public creation of knowledge and R&D, the diffusion of knowledge, and the formation of human capital. Financial support given to the firm sector and the regulation of competition are going to be discussed in the subsequent section *Regulatory Framework and Business Environment*. Finally, in the section *Demand-Side*, I am going to discuss all measures concerning public procurement and public services as well as the involvement of users in the innovation process. Over the following sections, I am going to outline the single criteria and define the policy measures they include, and I am further going to give some considerations regarding the relevant influencing factors on the described policy approaches. This chapter is then going to be concluded by a summary and an overview of the analytical framework developed.

For all listed criteria, it is important to acknowledge that there will be crossovers among the chosen criteria, which need to be kept in mind when applying the framework to the respective country cases. I am going to point out the most evident areas in which such crossovers might occur during the discussion of each respective criterion. Furthermore, within each parameter,

the question whether specifics regarding certain sectors or regions have been explicitly included in policy strategies must be an area of consideration.

3.2 Knowledge Creation, Information Diffusion, and Skills

3.2.1 Creation of Knowledge and Public R&D

This criterion of the analytical framework is focused on policy targeting the support of universities, technological institutes, R&D laboratories, and research institutions (Lundvall & Borrás 2005, 614) to bolster basic research and its provision as a public good (Pavitt & Patel 1999, 101). Financial policy instruments used are block grants, direct funding (Edquist 2006, 193), as well as competitive research funding (Borrás & Edquist 2013, 1517). Funding can be distributed by generally supporting core sciences or by supporting specific projects, strategies chosen can be either long-term or short-term in nature, and allocation criteria can be competitive and based on performance (OECD 2015, 91-2; Paic & Viros 2019, 23). Besides instruments based on public funding, adjustment of governance of research as well as scientific education, and statutory regulations of research institutions (Borrás & Edquist 2013, 1516), the provision of physical research infrastructure as well as efforts towards promoting research multidisciplinarity and interdisciplinarity (OECD 2015, 91-2) need to be taken into consideration. Furthermore, the support given to domestic research organizations to partake in international cooperation in science and technology by providing networks and infrastructure necessary for research and by directly promoting research cooperation with other countries (OECD 2015, 97-8) needs to be addressed.

Within this criterion, it is important to keep in mind the influence targeted funding schemes can have on defining technology or industry specific technology policies (Lundvall & Borrás 2005, 608), and how evaluation processes are utilized to make decisions on allocating public research funds and incentivizing specific research fields (Lundvall & Borrás 2005, 607). The distribution of tasks among the single public R&D organizations also needs to be considered (Edquist 2006, 193-4) as well as the efforts made to combine basic with applied research (Speta 2017, 29).

3.2.2 Information Diffusion and Technology Adoption

Analyzing policy tools in place that enable the spread of information among all stakeholders within the national innovation process, this criterion is going to take a closer look at measures targeting the diffusion of information and its availability (Stoneman & Diederen 1994, 920-1),

including technology transfer via information and knowledge exchange (Bozeman 2000, 629) and the linking and integration of public and private R&D efforts (Lundvall & Borrás 2005, 607; Lee et al. 2018, 10). While policy targeting regulatory or economic aspects naturally also influences the diffusion of information, on the supply-side, diffusion can be facilitated by supporting innovators in adapting their technology to market needs (Caiazza 2016, 1411). Strategies surrounding the adoption and diffusion of new technology can be centered around areas such as awareness-raising, capacity building, providing access to testing facilities, incubation activities, promoting technology improvement, the provision of technology expertise and consultancy services, or enabling firms to commercialize innovation through technical and financial support (Planes-Satorra & Paunov 2019, 28-30; Caiazza 2016, 1413; Edquist & Hommen 2008, 10). Measures in this regard attempt to counter imperfect information and to increase the speed at which information is diffused (Stoneman & Diederen 1994, 927), make scientific data more accessible by means of open science, generate spillovers, and facilitate the interlinking of different fields of research (OECD 2015, 94-5). R&D is of course carried out by both public institutions as well as private firms, leading to the creation of both publicly and privately owned knowledge (Edquist 2006, 193). Private and public users of research can be linked through measures such as management contracts between private organizations and public research institutions (Borrás & Edquist 2013, 1518) or public enterprise in the form of public-private partnership (Borrás & Edquist 2013, 1516-8), connecting private and public technology sectors (Hutschenreiter et al. 2019, 25-7). Collaboration in innovation efforts can be strengthened by connecting firms and research by providing networks and infrastructure for collaborative research, founding innovation centers and centers of excellence, allowing for spin-offs, and internationalizing it by establishing transnational agreements and organizations (Paic & Viros 2019, 25; Planes-Satorra & Paunov 2019, 31-5; OECD, 2015, 91; Archibugi & Iammarino 1999, 264). Technology transfer strategies include such that aim at establishing technology transfer alliances between research organizations and can be designed around for-profit models, free agency models, or internet platforms (OECD 2015, 100-4), usually in connection with knowledge networks and knowledge markets (OECD 2015, 115-6).

Some obvious crossovers with other criteria of this framework are the fact that diffusion, of course, is not just made possible by means of information provision but also through other measures such as subsidies (Stoneman & David 1986, 142), and that demand-side issues in connection with diffusion (Caiazza 2016, 1409-10), especially in the area of innovation awareness (Guimón & Paunov 2019, 9), play an important role in this regard. The role of knowledge

flows, knowledge rights, its co-creation, as well as the mobility of skills, also have a certain influence on this criterion (OECD 2015, 117). Those areas are going to be elaborated on separately in later sections of this chapter. Other details to keep in mind when assessing diffusion policy are their potential focus on SMEs (Stoneman & Diederen 1994, 927; Caiazza 2016, 1413; OECD 2015, 95), the limitation of spill-over effects to a certain cluster (Tödtling & Trippl 2005, 1207-8), and the difference between the input of universities and that of government laboratories (Bozeman 2000, 635-6).

3.2.3 Human Capital and Skill Development

This part of the analytical framework comprises all efforts that aim at driving innovation through HR-related policies (Mani 2002, 31) and therewith support the development of workforce skill and human capital overall. The area of competence building within the human capital by educating, training, and engaging in talent development of skilled personnel (Edquist 2006, 195; Lee et al. 2018, 10) can be approached in several ways: The role of educational institutions, such as schools and universities (Edquist 2006, 195), in supporting innovation can be adjusted through measures regarding the regulation, organization, and funding of the national education system (Borrás & Edquist 2015, 220). Innovation can further be fostered within and throughout working life itself, by incentivizing vocational training schemes as well as on-the-job training, apprenticeships, and learning by doing (Edquist 2006, 195-6; Borrás & Edquist 2015, 220). Specific educational areas to keep in mind when analyzing policy approaches are the fostering of problem-solving skills, entrepreneurship, and communication skills, as well as whether there is a focus on a broader humanitarian education, multi- and interdisciplinarity, technical literacy, and lifelong learning (Speta 2017, 27-8; OECD 2015, 54-6). Preventing possible skill bottlenecks (Hutschenreiter et al. 2019, 23-4) and making the pursuit of academic careers more attractive by improving career development opportunities and monetary rewards as well as adjusting overall employment regulations for researchers can further support the innovation process (OECD 2015, 57; Borrás & Edquist 2013, 1516). Besides educational aspects, public policy can reduce mismatch and waste of skills by matching workers and jobs more efficiently (OECD 2015, 53), improve processes for recruiting and training researchers (OECD 2015, 92), allow entrepreneurs to catch up by providing business accelerators (OECD, 2015, 134), and, by removing access barriers, improve women's participation in the innovation process (OECD 2015, 53). Migration policies (Borrás & Edquist 2015, 220) must also be considered, including the adjustment of foreign workers' access to the domestic labor market (Borrás & Edquist 2015, 222) as well as measures regarding reverse brain drain (Borrás & Edquist 2015, 220) and

improving access of skilled international workers by enhancing global mobility (OECD 2015, 53). Furthermore, possible policy approaches towards strengthening the support for external competence building need to be considered, such as HR development by means of university-industry relations (Borrás & Edquist 2015, 219-20).

Some aspects to keep in mind when assessing this criterion are the existence of a potential focus on certain workforce skills on a national level (Pavitt & Patel 1999, 103-4) and considerations regarding the general adjustment of regulation concerning wages (Lee et al. 2018, 8). Attention must also be paid to whether there is a focus on balancing internal and external competences (Borrás & Edquist 2015, 225) as well as to the potential crossovers with the previous criterion around the topic of mobility of skills and knowledge flows due to the knowledge embodied in workers (OECD 2015, 117).

3.3 Regulatory Framework and Business Environment

3.3.1 Financial Incentives to Enterprises

Policy tools providing financial incentives to the private sector through financing of innovation processes (Edquist & Hommen 2008, 10) are manifold. Direct stimulants can be induced by providing economic subsidies (Lundvall & Borrás 2005, 607) and by means of investment (Hutschenreiter et al. 2019, 24), with the general aim of improving capital fluidity (Lee et al. 2018, 7-8). Asset financing as well as debt and equity financing (OECD, 2015, 78) can be publicly provided in the form of loans, loan guarantees, credit loans, credit guarantees, advances, research grants, equity investment, risk capital, risk-sharing, and mezzanine funding (OECD, 2015, 124; Paic & Viros 2019, 23-4; Mani 2002, 36; OECD, 2015, 77). Support can be provided indirectly by facilitating access to venture capital, seed capital, early-stage financing, business angels, and government-backed venture capital (OECD, 2015, 124; Lundvall & Borrás 2005, 612; Borrás & Edquist 2013, 1517; OECD, 2015, 75; Mani 2002, 36) as well as by allowing for public listings of SMEs (OECD, 2015, 77). Besides funding measures, indirect financial support can be offered by means of tax benefits: tax relief aimed specifically at incentivizing and encouraging domestic R&D activities in the form of tax reductions, tax exemptions, tax incentives, and tax credits (Lundvall & Borrás 2005, 607; OECD, 2015, 74; Lundvall & Borrás 2005, 610; Borrás & Edquist 2013, 1517; Mani 2002, 36; Paic & Viros 2019, 23-4).

When assessing innovation policy within this criterion, attention must be paid as to whether financial incentives have been designed to promote innovation and research in distinct key

areas, specifically concerning digital technologies (Planes-Satorra & Paunov 2019, 37), and to what those are. Furthermore, and this concerns both criteria in this subsection, the question whether instruments in place support entrepreneurship and market entry for new firms and allow for market exit of less productive ones needs to be considered (OECD, 2015, 79; Planes-Satorra & Paunov 2019, 40-1). Crossovers to be mindful of are those with demand-side efforts, such as infrastructure funding (Guimón & Paunov 2019, 8), as well as those of taxation schemes which incentivize intellectual property (OECD, 2015, 125-6), which is going to be elaborated on in the following section.

3.3.2 Competition, Intellectual Property, and Standards

Looking at the respective policies in place, this section of the analytical framework is going to shed some light on measures regulating competition aiming at facilitating innovation processes (Lundvall & Borrás 2005, 612-3) and on how laws and technical standards are adjusted to that same end (Edquist 2005, 2). By targeting issues such as cartelization, vertical restrictions, or merger regulation, antitrust policies provide a common form of competition regulation in the innovation policy field (Borrás & Edquist 2013, 1516-8; Speta 2017, 15-8) and allow for market entry by interconnecting new enterprises with persistent monopoly (Speta 2017, 21). Competition regulation can also act as a means to prevent international exploitation (Archibugi & Iammarino 1999, 261), and international competitiveness can be improved by adjusting tariff and non-tariff barriers, export restrictions, trade agreements, and currency regulations (OECD, 2015, 82; Lin et al. 2013, 123). Regulation regarding intellectual property can be modified by directly targeting overall patent law (Lundvall & Borrás 2005, 612; Borrás & Edquist 2013, 1516; Paic & Viros 2019, 24; Edquist & Hommen 2008, 10), the transaction of knowledge, knowledge rights, knowledge co-creation (OECD 2015, 117), and, as mentioned in the previous section, by utilizing taxation schemes that incentivize intellectual property assets (OECD, 2015, 125-6). Technical innovation-oriented standards can be imposed (Stoneman & Diederen 1994, 922; OECD, 2015, 142-3), and efforts can be made towards altering health, safety, environmental, as well as ethical regulations to drive innovation processes (Edquist 2005, 2; Edquist & Hommen 2008, 10; Speta 2017, 21-6; Borrás & Edquist 2013, 1516-7). Here, a possible influence exerted by policymakers on implementing soft instruments including CoCs and voluntary technical standards as well as their overall approach towards shaping cultural and social norms must be taken into consideration (Borrás & Edquist 2013, 1518; Edquist 2005, 2).

Possible crossovers to other criteria might be the fact that the issue of technical standards could be part of a general diffusion strategy (Stoneman & Diederen 1994, 922), and that trade, tariffs, and currency-related matters could also be treated as demand-side issues (Lin et al. 2013, 123). Similarly, quality requirements, which in turn influence the formation of standards, might originate from the demand-side (Edquist & Hommen 2008, 10). It is therefore important to keep in mind how social aspects influence innovation policy compositions (Buhr 2015, 13-4).

3.4 Demand-Side

3.4.1 Public Procurement and Public Services

Aiming at increasing the demand for certain kinds of innovation by improving the conditions for their adaptation (Caiazza 2016, 1412), in this criterion, demand-side measures designed to form new product markets around the notions of public procurement and public services are comprised (Lin et al. 2013, 123; Edquist & Hommen 2008, 10). Public procurement, more specifically public technology procurement (Guimón & Paunov 2019, 8), in the form of R&D contracts, government contracts and purchases, or prototype purchasing (Lin et al. 2013, 123; Caiazza 2016, 1412-3) can be utilized as an instrument to promote specific technologies, sectors, and economic goals by creating demand for R&D and new technologies by incentivizing their development (Lundvall & Borrás 2005, 610; OECD, 2015, 124). Additionally, public markets can be established to further support procurement measures (Paic & Viros 2019, 24-5). On the other hand, demand can also be stimulated by delivering public services by acquiring, maintaining, managing, and innovating areas such as telecommunications, transport, construction, health services, or public building (Lin et al. 2013, 123).

Besides the potential crossovers that have already been mentioned in the previous sections, there are several accounts in the literature classifying certain measures as demand-side policy tools, which, in the course of this analysis, are, however, going to be allocated within different categories: Areas such as training or certain types of financial support are among those that have in other frameworks been allocated to the demand-side (Caiazza 2016, 1413). Furthermore, joint research, public-private partnerships, ownership of public-private research, and the funding of infrastructure such as science parks, business incubators, or technology transfer offices as well as technology roadmapping and collaboration activities have been classified as demand-side measures (Guimón & Paunov 2019, 9; Lin et al. 2013, 123). Although those areas have, in other works, been categorized as demand-side activities, they fall into different

categories in the scope of this thesis. Of course, attention, however, is going to be paid to their potential influence on the demand-side of innovation policy.

3.4.2 User Involvement in the Innovation Process

The last criterion of this framework focuses on policy measures targeted at involving users in the innovation process by defining existing needs as well as future challenges, aiming both at currently available innovation and innovation that has not yet been developed (Boon & Edler 2018, 437-8; OECD, 2015, 144-5). Demand-side measures mentioned in the literature that enable user involvement are such that improve interaction between producers and users and, at the same time, support the definition of challenges and needs (Boon & Edler 2018, 438). Policy tools utilized to do so are such that enable the involvement of relevant actors, including organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, the interlinking with emerging markets, lead users, as well as crowdsourcing activities (Boon & Edler 2018, 438; Edquist & Hommen 2008, 10; Borrás & Edquist 2015, 220).

Many of the mentioned policy approaches concerning user involvement are connected to the topic of raising awareness for innovation, which was already mentioned in a previous section of this framework, since relevant information is spread publicly through events or media communication (Borrás & Edquist 2013, 1518). Certain crossovers might also exist with certain aspects of standardization, training, and regulation, within which measures targeted at user involvement might be incorporated (Boon & Edler 2018, 438).

3.5 Summary: Analytical Framework

The following table illustrates all criteria, providing an outline of all policy areas and policy strategies described above as well as their respective areas of intervention. Furthermore, I am going to give an overview of the policy instruments identified, alongside the considerations regarding potential influencing factors and possible crossovers with other criteria within this framework. The column “policy instruments” therewith includes all possible policy approaches chosen by the respective governments.

Policy area	Policy strategy	Intervention area	**Policy instruments**
Knowledge creation, information diffusion, and skills	*Creation of knowledge and public R&D*	• Universities • Research institutions • Technological institutes • R&D laboratories	Direct funding, competitive research funding, block grants
			Adjustment of research governance & scientific education, statutory regulations of research institutions
			Provision of physical research infrastructure
			Promoting multi- & interdisciplinarity, promoting international cooperation
			Influencing factors: technology or industry specific policies, use of evaluation processes, incentivization of specific research fields, distribution of tasks among public R&D organizations, combining of basic research with applied research
	Information diffusion and technology adoption	• Information diffusion • Information availability • Technology transfer • Information & knowledge exchange • Linking & integration of public & private R&D • technology adoption	Capacity building, promoting technology improvement, provision of access to testing facilities, incubation activities, provision of technology expertise & consultancy services, enable commercialization of innovation through technical & financial support, awareness-raising
			Improve accessibility of scientific data through open science, generate spillovers, interlinking of different research fields
			Provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations
			Management contracts between private & public organizations, public-private partnership
			Establishment of technology transfer alliances between research organizations, provision of knowledge networks & knowledge markets
			Influencing factors: focus on SMEs, limitation of spillover effects to a certain cluster, input difference between universities & government laboratories *Crossovers: information diffusion is also possible through measures other than information provision, importance of demand-side topics in connection to diffusion / innovation awareness, influence of knowledge flows / knowledge rights / co-creation of knowledge / mobility of skills*
	Human capital and skill development	• HR / human capital development • Workforce development • Competence building • Education / training / skill development	Regulation / organization / funding of national education system
			Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing
			Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators

			Focusing broader humanitarian education / multi- & interdisciplinarity / lifelong learning / technical literacy
			Preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation
			Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility
			Strengthening support for external competence building, enable HR development through university-industry relations
			<u>Influencing factors:</u> focus on certain workforce skills on national level, general adjustments of wage regulation, efforts to balance internal & external competences *<u>Crossovers:</u> mobility of skills / knowledge flows due to knowledge embodied in workers*
Regulatory framework and business environment	*Financial incentives to enterprises*	• Financing of private innovation processes • Financial incentives to the private sector • Indirect financial support through access to capital & tax benefits	Direct stimulants in the form of economic subsidies & investment, improving capital fluidity
			Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding
			Indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings
			Tax benefits & relief aimed at supporting R&D activities such as tax reductions / tax exemptions / tax incentives / tax credits
			<u>Influencing factors:</u> promotion of innovation & research in distinct key areas / digital technologies, support of entrepreneurship / market entry / market exit *<u>Crossovers:</u> demand-side measures such as infrastructure funding, taxation incentivizing intellectual property*
	Competition, intellectual property, and standards	• Regulation of competition & intellectual property • Adjustment of laws & technical standards	Antitrust policies targeting cartelization / vertical restrictions / merger regulation, interconnecting new enterprises with persistent monopoly
			Regulating intellectual property through patent law / regulating knowledge transaction / knowledge rights / regulating knowledge co-creation / taxation schemes incentivizing intellectual property assets
			Imposing technical standards, altering health / safety / environmental regulations

			Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms
			Improving international competitiveness through adjusting tariff & non-tariff barriers / export restrictions / trade agreements / currency regulations, prevention of international exploitation
			<u>Influencing factors:</u> support of entrepreneurship / market entry / market exit *<u>Crossovers:</u> technical standards could be part of a general diffusion strategy, matters regarding trade / tariffs / currency could also be treated as demand-side issues, quality requirements influencing the formation of standards might originate from the demand-side*
Demand-side	*Public procurement and public services*	• Increasing innovation demand through improving adaptation conditions • Forming of new product markets through public procurement & public services	Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets
			Public services through acquiring / maintaining / managing / innovating areas such as telecommunications / transport / construction / health services / public building
			<u>Influencing factors:</u> potential influence of other measures on the demand-side *<u>Crossovers:</u> areas that could otherwise be classed as demand-side measures include training / financial support / joint research / public-private partnerships / ownership of public-private research / science parks / business incubators / technology transfer offices / technology roadmapping & collaboration*
	User involvement in the innovation process	• Involvement of users in the innovation process • Improving interaction between producers & users • Definition of existing needs / future challenges	Enabling involvement of relevant actors, organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, interlinking with emerging markets, lead users, crowdsourcing activities
			<u>Influencing factors:</u> potential influence of other measures on the demand-side *<u>Crossovers:</u> awareness-raising by spreading relevant information through events or media communication, aspects of standardization / training / regulation targeted at user involvement*

Table 1: Analytical Framework Overview

4. Empirical Part

4.1 Outline: Empirical Part

Over the course of this chapter, I will examine the strategic policy approaches as proposed by the governments of Japan and Korea. By applying the theoretical framework described in the previous section, the strategies in place regarding the advancement of the FIR by the respective governments and their institutions will be investigated. In a first step, an overview of those strategies and the institutions involved will be given in the subsequent section. This chapter will then be divided into sections based on the policy strategies, which are again separated into subsections according to the policy instruments identified respectively for Japan's and Korea's strategies.

4.2 Overview: Fourth Industrial Revolution Innovation Approaches of Japan and Korea

4.2.1 Japan: Society 5.0

Following its predecessors the hunting society, agricultural society, industrial society, and information society, Society 5.0, according to the Cabinet Office of Japan (CAO), aims to solve economic as well as societal issues, specifically such surrounding the aspects of region, age, gender, and language, which is made possible by the convergence of virtual and physical systems and the improvement of AI, big data, IoT and robotics technologies (CAO 2020a). By utilizing those new technologies, the Keidanren (Japan Business Federation) states that Society 5.0 will, through digital transformation, make possible fundamental reforms in the business, finance, HR, and public sectors, and furthermore assist in delivering on the United Nations' Sustainable Development Goals (SDGs) (Keidanren 2018). Society 5.0 has been described as a strategy to improve people's overall quality of life by utilizing the technological potential of the FIR, its success depending on entrepreneurial efforts as well as public innovation policy (Ferreira & Serpa 2018, 28-9). Along with the Society 5.0 approach, the "New Industrial Structure Vision", a strategic outline as of how to respond to the FIR provided by the Ministry of Economy, Trade and Industry (METI), mentions the "Connected Industries" initiative as the second crucial aspect in realizing Japan's future society and economy (METI 2018). The Connected Industries initiative, which I will later elaborate on in more detail, pursues a

transformation into an ideal state of the industry for supporting the realization of Society 5.0, adding new value by connecting organizations, people, machines, and technology on both national and transnational levels (METI 2018).

As already mentioned earlier on, Japan's 5th Science and Technology Basic Plan was promoting Society 5.0 as the chosen approach towards achieving a Super Smart Society, in which cyberspace and physical space merge together (CAO 2016, 10-1). After the "Science and Technology Basic Law" of 1995 was replaced by the new "Science, Technology and Innovation Basic Law", which was enacted in 2020, the formulation of a 6th Science, Technology and Innovation Basic Plan (henceforth basic plan) was announced in late 2020 (CAO 2020b). The cabinet office argues that the revision of the law is a complete overhaul of its predecessor, and states that adjustments were necessary due to the changing geopolitical situation, issues related to global change, the impact of the COVID-19 pandemic, as well as the need to reform the current information society (Society 4.0) overall (CAO 2021, 4-8). In January 2021, a first draft of the new basic plan was released, setting out to aid in solving those issues by focusing on realizing Society 5.0 through concentration on knowledge as the foundation of value creation, the fusion of cyber and physical space, as well as the fostering of the necessary HR (CAO 2021, 9-12). The objective is to create a diverse and sustainable society in which safety and well-being can be provided to everyone, as well as to function as a model society for other countries around the globe (CAO 2021, 10-3).

The realization of Society 5.0, along with the plan to achieve sustainable growth, is currently being stated as one of the two main goals of Abenomics, a set of economic policies advocated by former Prime Minister Shinzō Abe and his administration (JapanGov 2020, 4-5). The solutions outlined to achieve this "national vision aimed at realizing a data-driven, human-centric society for our future generations" evolve around innovating societal structures, fostering diversity and empowerment among people, creating smart laws and regulations, making international business opportunities more attractive, and improving the competitiveness of businesses (JapanGov 2020, 5). Although Prime Minister Abe has resigned from his office in August 2020, his successor Yoshihide Suga has stated his intent to continue the Abenomics approach (Nagata 2020). Having been Abe's number two throughout his time as prime minister and having played a crucial part in the conception and execution of the Abenomics framework (Sposato 2020), Prime Minister Suga's approach, which has been dubbed "Suganomics", is expected to be a continuation of his predecessor's economic policies (Takenaka 2020). At the time of writing

this, no changes regarding the approaches towards policy targeting the FIR or the overall Abenomics framework have been publicly announced.

Under the guidance of the METI, the Japanese government has introduced a strategy consisting of a number of policy initiatives under the name Connected Industries, which focuses specifically on the role of industries in Society 5.0 (METI 2019). Similar to the German Industry 4.0 project, goal of the Connected Industries initiative is to improve manufacturing processes by enhancing cooperation between the public and private sectors, and it further proposes to create stronger connections within Japan's manufacturing industry itself, putting emphasis on priority fields such as automated driving and mobility services, robotics, or biotechnologies (METI 2019). By facilitating collaboration between industry, academia and government through improving cross-sectoral efforts such as data utilization, standardization, or cybersecurity, this initiative aims to boost productivity, information dissemination, and, ultimately, innovative progress (METI 2017, 4). It is important to note that although the Connected Industries approach does focus on connecting various industries and increasing industrial competitiveness, it does, by doing so, also seek to solve social issues surrounding areas such as environmental challenges, energy production, labor shortages, or the aging society (METI 2017, 7).

4.2.2 Korea: The PCFIR, I-Korea 4.0, Growth through Innovation, and the Digital New Deal

Korea's current administration under President Moon Jae-in, who was elected into office in May 2017, proclaimed the preparation for the FIR as one of the key factors in achieving their policy objective to attain innovative growth, and announced to launch a presidential committee to promote demand-based R&D strategies and to support the development of FIR technologies (MOEF 2017a). In a cross-ministerial coordination effort, the PCFIR's mission is to develop a national plan addressing the challenges posed by the FIR (Planes-Satorra & Paunov 2019, 24). The PCFIR assumes the following four functions as its main roles: Firstly, the foundations of science and technology are to be secured, new industries and services are to be fostered, and social change is to be addressed (PCFIR 2017). Secondly, the basis of institutional and regulatory improvement is to be established in collaboration between public and private actors (PCFIR 2017). Thirdly, the creation of a new industrial ecosystem is to be supported (PCFIR 2017). Fourthly, the FIR is to be promoted publicly and participation in it is to be encouraged (PCFIR 2017). The most recent recommendation by the PCFIR was released in late 2019 under the title "Government Recommendations on the 4th Industrial Revolution" (PCFIR 2019). Aiming to present the government with policy directions containing the opinions of the private

sector regarding the FIR (PCFIR 2019, 3), the PCFIR identifies the focus areas of HR development and the establishment of intelligent infrastructure based on FIR technologies as key drivers of industrial and social innovation (PCFIR 2019, 49-51). In this most recent publication, the PCFIR provides a comprehensive catalogue of recommendations towards FIR innovation, structured around the areas of social innovation, such as in the labor market or education system, industrial innovation, focusing on areas such as smart manufacturing or logistics, as well as intelligent technology development, aiming to improve areas such as the AI and data environment (PCFIR 2019, 54-75).

As already touched upon in the introductory chapter, the I-Korea 4.0 initiative, which was conceived by the MSIT with support of various other ministries and the PCFIR, was first announced in 2017 as a five-year government plan to foster innovative growth towards the FIR across all sectors (MSIT 2017, 3). Listing it as one of their main initiatives, the MSIT identifies the main targets of the I-Korea 4.0 plan as the improvement of quality of life, the advancement of data, AI and networking systems, the fostering of the R&D environment, as well as the renewal of working styles (MSIT 2019). The full policy proposal was released in late November 2017 titled "People-centred 4th Industrial Revolution Response Plan for Innovative Growth" (MSIT 2017). While identifying a number of national competitive advantages in meeting the FIR, such as science and HR capacities, the response plan also admits to some shortcomings, such as a relatively low rate of industrially utilized intelligent technologies and an inflexible labor market (MSIT 2017, 29). Aiming to realize the FIR in a way that all members of society can benefit from, the plan aims to create and foster new industries based on intelligent technologies, to enhance the quality of live by addressing social issues, to adjust to the changing labor market by creating new jobs and enhancing social security systems, and to enable the development of world-class technologies that can be used by everyone (MSIT 2017, 34). The main tasks outlined by the I-Korea 4.0 response plan are the promotion of intelligent technology projects, the securing of growth engine technologies, the establishment of industrial ecosystems and infrastructure, as well as addressing future societal change (MSIT 2017, 36-83).

Following the announcement of the Growth through Innovation initiative, the Ministry of Economy and Finance (MOEF) released a report specifying the roles which single ministries had to serve in furthering the FIR under the innovative growth approach, dividing them in focus areas such as building modern infrastructure, adjusting trade and financial structures, regulating job creation, and establishing a culture of innovation (MOEF 2018a). In their policy outlook for the year 2019, the MOEF had stated a specific focus on preparing for the FIR through

improving the environment for R&D, workforce development and improvement of education, as well as by working towards a platform economy and furthering industrial convergence (MOEF 2018b). The general policy areas outlined to achieve innovative growth are boosting industrial innovation through science and technology advancements, fostering HR innovation though talent development and education, and creating a social system of innovation by promoting the vitalization of businesses and adjusting labor conditions (MOEF 2020d). In August 2019, the MOEF published their strategy outline on how to accelerate the Growth through Innovation strategy and on policy measures to improve the diffusion of innovation, dividing policy areas into expansion of corporate innovation capability, fostering an industrial ecosystem, facilitating public diffusion of innovation, and reinforcing innovation bases (MOEF 2019, 7).

The Korean New Deal was publicly announced in the summer of 2020 in response to the COVID-19 pandemic and global change, identifying its main goals as aiding the transition from a carbon-dependent economy to a green one, creating a more inclusive society, and taking on the role of an economic leader (MOEF 2020c). The three major projects outlined are the "Digital New Deal", focusing on aspects such as industrial convergence and digital education infrastructure, the "Green New Deal", which focuses areas such as eco-friendliness and decarbonization, as well as the overall creation of stronger safety nets through social safety and HR investment (MOEF 2020c). In the conception of the Korean New Deal, the goal was set to "focus on a transformation into a digital economy, and preparation for the 4th industrial revolution and a post-COVID-19 economy" (MOEF 2020b). In particular, the Digital New Deal has been identified as the main policy approach towards driving forward the FIR through fostering data-related industries, AI development, as well as digital contact-free industries (KBS WORLD Radio, 2020). The comprehensive plan outlining the details of the Korean New Deal identifies the main goals of the Digital New Deal as the enhancement of AI, 5G, and data capacities across all industries, the improvement of convergence education and learning, the creation of contact-free infrastructure, as well as the digitization of social overhead capital (MOEF 2020a, 10-3).

4.3 Creation of Knowledge and Public R&D

4.3.1 Japan

Direct funding, competitive research funding, block grants

Aiming to facilitate the creation of knowledge through academic research, the basic plan sets out to secure the provision of financial resources in the form of research funds to public research institutions and universities, as well as to further widen the scope of that support in the future (CAO 2021, 51). The basic plan promotes the realization of reforms towards a more competitive research funding system, with the goal of enabling the seamless support of basic capabilities in emerging and integrated research fields (CAO 2021, 55). To that end, the basic plan aims to simplify and accelerate processes regarding the provision of research funding through unifying and digitizing administrative procedures (CAO 2021, 55). Additionally, the basic plan seeks to facilitate access to funding by improving cooperation between funding institutions, as well as by simplifying mechanisms surrounding indirect competitive research expenses (CAO 2021, 55). In order to be able to better examine research funding results and to identify priority areas for the next policy cycle, the basic plan sets out to further strengthen research funding evaluation methods (CAO 2021, 55).

Furthermore, in the face of Japan's declining international competitiveness and the weakening of the financial base of its universities, the basic plan aims to boost the public university sector by establishing a 10 trillion yen university fund (CAO 2021, 63). This fund is to be dedicated to enable universities, which the basic plan identifies as the core of the national innovation ecosystem, to carry out world-class R&D, to establish a leading research base, to build HR that meet the needs of society, as well as to manage themselves autonomously and to commit to responsible governance (CAO 2021, 63-4). In order to make the allocation of funding and grants more fair and diverse, the basic plan also sets out to improve the objectivity of performance indicators, and to review evaluation processes on an annual basis (CAO 2021, 64).

To enable stable financial management within public universities, the basic plan advocates for the expansion of bond issuance, and for allowing more flexible use of indirect expenses covered by public funding (CAO 2021, 63). Moreover, to make financial processes more transparent and efficient, the basic plan promotes a review of current accounting standards within universities, as well as to establish mechanisms to accumulate financial resources acquired by university organizations themselves (CAO 2021, 63). Aiming to improve the quality of research and education of private universities, the basic plan points out the national government's

intention to improve subsidy allocation processes for non-public universities (CAO 2021, 64). In addition, the basic plan states that the *Ministry of Education, Culture, Sports, Science and Technology* (MEXT) aims to further review and improve funding processes for both public and private universities from 2021 (CAO 2021, 64).

Adjustment of research governance & scientific education, statutory regulations of research institutions

In a general attempt to adjust management processes within the public university sector, the basic plan attempts to convert national university organizations to true management bodies, aiming to deregulate them in order to support strategic management, and to continuously evaluate their business performance (CAO 2021, 63). Measures to facilitate this reform include a shift to more autonomous decision-making and management, allowing for strategic management through providing modern financial and accounting systems, and the introduction of a new nationwide evaluation system for public universities (CAO 2021, 64). To simplify processes for organizational restructuring, the basic plan encourages the efficient allocation of internal resources overall, making way for more autonomous management and decision-making in the areas of student capacity and the setting of tuition fees (CAO 2021, 63-4). As far as the development of university staff goes, the basic plan promotes the adjustment of selection mechanisms for university presidents with attention on their strategic management capabilities, as well as the introduction of a more competitive salary system capable of attracting world-class researchers (CAO 2021, 64). In order to maximize the time spent on conducting actual research within universities, the basic plan also sets out to streamline administrative processes by promoting good practices regarding effective research management, digitization and simplification of paperwork and administrative processes, and by employing specialized staff to implement such measures (CAO 2021, 52-3). Besides improving funding processes, according to the basic plan, the MEXT also aims to support the advancement of universities in aspects regarding research staff and academic environment (CAO 2021, 64). The ministry furthermore looks to bolster the operational and financial capacities of the *Japanese National Research and Development Agencies*, enabling them to fulfill their responsibilities of maximizing R&D results and driving forward innovation (CAO 2021, 65).

To strengthen emergent research, the basic plan sets out to continually promote the improvement of research systems in place, breaking away from approaches that are short-termed or simply performance-based (CAO 2021, 51). The plan therefore advocates to create a research environment that focuses on long-term approaches, integrated research, and within which

support to young researchers is being provided (CAO 2021, 51). It also urges researchers to actively look at issues that are expected to have an impact on future society, an approach which is being referred to as the "Moonshot type R&D system" (CAO 2021, 42). The basic plan further states that if private R&D efforts towards certain highly necessary technologies should be discontinued due to environmental changes, such as the COVID-19 pandemic, public agencies are to assume innovation activities in those areas (CAO 2021, 35). The plan promotes the design of a framework specifying the takeover of R&D efforts for technologies that are deemed necessary to be retained in Japan (CAO 2021, 35).

Provision of physical research infrastructure

The basic plan states the general intent to further advance technologies utilized to improve academic infrastructures, promoting their development based on scientific evaluations of technology demand (CAO 2021, 59). It is pointed out that Japan's national government is looking to formulate guidelines for the sharing of public research facilities by 2021, which aim to allow for the sharing of research equipment and research spaces across the country (CAO 2021, 59), an effort which is also stated as an integral part of the university funding strategy mentioned above (CAO 2021, 63). Starting from 2022, universities and other public R&D institutes are to formulate policies addressing the sharing of facilities and equipment inside their organization, and the basic plan aims to roll out a nation-wide centralized system for inquiries in this regard (CAO 2021, 59). In addition to allowing for shared use, this system is also meant to provide insight into how R&D institutions are situated in terms of research equipment and facilities, and to where maintenance or renewal is necessary (CAO 2021, 59). As a specific project that aims to make supercomputing capacities more widely available, the basic plan promotes the sharing of the supercomputer *Tomitake* to meet computing needs of universities and other R&D institutions across the country (CAO 2021, 20).

Promoting multi- & interdisciplinarity, promoting international cooperation

The basic plan sets out to improve efforts towards basic research, particularly in emerging and integrated fields, by bringing together a wide range of disciplines, including the social sciences and humanities (CAO 2021, 51). The basic plan intends to facilitate this fusing of fields through promoting inter-university and joint research, both on domestic and international levels, and, by doing so, also identifies the possibility of creating new fields (CAO 2021, 51-2). Through utilizing what is being referred to as "comprehensive knowledge", the basic plan sets out to fuse knowledge created within the realm of social sciences and humanities with that of the natural sciences (CAO 2021, 41). The plan advocates to design innovation strategy by

integrating humanities with sciences from early stages of R&D and states the intent to bolster funding for areas within which comprehensive knowledge is being created (CAO 2021, 43). To enhance the use of joint research approaches that transcend university boundaries, the basic plan sets out to institute a research support system focusing on issues faced by future society, within which contributions by social sciences and humanities on the development of technology are also taken into consideration (CAO 2021, 54). The basic plan states that research funds are to be provided towards this area specifically, and that the roll-out of the comprehensive knowledge strategy will be initiated in 2021 (CAO 2021, 54). In order to solve social issues around areas such as declining birth rates and aging population, environmental challenges, diseases and natural disasters, regional revitalization, or food and energy management, the basic plan states that strategies are to be designed around evidence provided by the scientific community, emphasizing the importance of taking contributions from both the natural sciences as well as humanities into account when drafting new polices (CAO 2021, 42).

In order to strengthen international cooperation within the knowledge creation and R&D field, as well as to ensure research integrity, the basic plan sets out to formulate guidelines regulating international joint research efforts around areas like overseas research funding, cooperation with foreign firms, and building an international research network in Japan (CAO 2021, 44). The basic plan further proposes to expand efforts towards reaching cross-national consensus on joint innovation research activities by applying science and technology diplomacy strategies such as strategic expansion, and dispatching staff to international decision-making positions (CAO 2021, 44). To promote international joint research and international brain circulation, the basic plan advocates for conducting joint research with developed countries that possess high technology and science standards on the one hand, and to coordinate technology cooperation focused on the SDGs with developing and emerging countries on the other hand (CAO 2021, 52). To further improve the environment for transnational collaboration within academia, the basic plan further sets out to bolster the international exchange of researchers and students, to improve international and overseas research fund allocation mechanisms, and to invite excellent research personnel from abroad (CAO 2021, 52).

4.3.2 Korea

Direct funding, competitive research funding, block grants

The I-Korea 4.0 response plan briefly identifies the need to introduce a R&D investment platform which breaks away from the budget review method (MSIT 2017, 68), specifics on its realization are however not being provided.

Adjustment of research governance & scientific education, statutory regulations of research institutions

In order to allow universities to engage in innovative activities autonomously, as well as to innovate curricula in consonance with technological developments, the PCFIR suggests providing government support in undertaking the necessary restructuring and specialization processes necessary to deliver FIR education (PCFIR 2019, 56). The committee furthermore promotes the expansion of financial autonomy held by universities, aiming to strengthen self-sustainability and competitiveness in the university sector (PCFIR 2019, 56). Besides taking on an active role in supporting innovative processes within academia through delivering direct support and expanding autonomy, the committee also suggests establishing a system to evaluate the success of such efforts (PCFIR 2019, 56-7). As one of the main means to innovate the R&D system, the I-Korea 4.0 initiative suggests creating a researcher-centered environment, in which excellent researchers are given the opportunity to engage in research autonomously and at the highest possible level of creativity (MSIT 2017, 66). In order to establish such an environment, the initiative promotes open group planning activities in the form of demand surveys or expert workshops, to introduce a modernized and more accessible review system for proposals, and to extend minimum support periods for competitive research activities (MSIT 2017, 66-7). Furthermore, the initiative advocates for making evaluation and selection processes of researchers more objective and fair by extending evaluation periods and by establishing a comprehensive expert database (MSIT 2017, 66-7).

Provision of physical research infrastructure

No specific projects surrounding the provision of physical research infrastructure have been pointed out by the Korean policy frameworks assessed.

Promoting multi- & interdisciplinarity, promoting international cooperation

As a means of supporting convergence and interconnection between industries, the Growth through Innovation initiative mentions the development of convergence technology through expanding the scale of current interdisciplinary technology development projects (MOEF 2019,

21). Aim of this endeavor is to establish an environment in which barriers between academic fields are being transcended, as well as to connect the stages of research from first conception to application (MOEF 2019, 21), however, specific measures on how to achieve this goal are not being introduced.

4.4 Information Diffusion and Technology Adoption

4.4.1 Japan

Capacity building, promoting technology improvement, provision of access to testing facilities, incubation activities, provision of technology expertise & consultancy services, enable commercialization of innovation through technical & financial support, awareness-raising

Seeing as the development of new technologies as well as business models can pose a risk for private firms, the Abenomics framework sets out to nurture companies by providing them with regulatory sandbox environments (JapanGov 2020, 10). Within the provided sandbox, new and early-stage ideas, such as technologies or businesses, can be tested in a real-life but unrestricted environment (JapanGov 2020, 10). After applying for the approval through a dedicated office, demonstration projects can be run swiftly and under relaxed rules and can after completion be submitted to be evaluated by the government with respect to their merit (JapanGov 2020, 10). If the new businesses or technologies demonstrated pass evaluation successfully, the government is then, as I will elaborate on later, to implement regulatory reforms accordingly (JapanGov 2020, 10).

The basic plan advocates for the creation of "smart cities", a concept that focuses on improving diversity and sustainability of cities and regions in order to realize Society 5.0 and, through collaboration of public and private efforts, allows for the development of regions and cities in accordance with future requirements, as well as the creation of data linkage infrastructures (CAO 2021, 15-6). In addition to it providing the opportunity to raise public awareness towards data collaboration (CAO 2021, 20), the smart city concept, at its core, is promoted as a measure to develop communities, identifying it as a strategy that revolves around sustainably creating values within communities by improving management and planning approaches, as well as by utilizing new data and computing technologies (CAO 2021, 36). Putting emphasis on topics such as industrial and environmental revitalization, the concept further calls for the interconnection of smart city entities through advanced data linkage platforms, as well as for

its expansion to an international stage (CAO 2021, 38-9). A "Smart City Guidebook" has been created in 2020, with the aim of supporting regions across the country in transitioning towards the smart city concept, and the basic plan also sets out to foster HR capable of deploying those guidelines (CAO 2021, 38-9).

Attempting to foster innovation processes towards Society 5.0 within the startup sector specifically, the basic plan sets out to implement a system across government agencies and ministries to further promote the commercialization of R&D results of small businesses (CAO 2021, 33). Based on the given social needs, this system aims to do so by enabling the development of startups as ventures from universities and public research institutions, as well as through providing them with the necessary funding (CAO 2021, 33). The basic plan proposes the formation of a startup ecosystem based around universities across the country to ensure that these support measures can be provided on a large scale (CAO 2021, 34).

Improve accessibility of scientific data through open science, generate spillovers, interlinking of different research fields

As an approach towards furthering the comprehensive knowledge strategy, the basic plan sets out to establish a data platform that provides central access to research data in the social sciences and humanities fields by 2022 (CAO 2021, 54). In addition to strengthening research capabilities within academia, this platform is also meant to support policy analysis and design by allowing for the collaboration of researchers and government officials on topics surrounding the future of society (CAO 2021, 54). With the aim of establishing an environment in which research data can be administered and utilized appropriately, the basic plan promotes the further development of the NII Research Data Cloud, Japan's central platform for managing research data, which was first introduced in 2020 (CAO 2021, 58). In order to improve the data collection and management mechanisms, public institutions conducting R&D, such as universities or national research institutes, are being encouraged to formulate governance policies for research data created through public funds, as well as to hire staff in charge of curating data (CAO 2021, 58). Additionally, aiming to make publicly generated data accessible to academia, the public sector, and industry, the basic plan promotes the provision of systematic meta data to research data (CAO 2021, 58). By doing so, data can be easily searched by all stakeholders on the research data infrastructure system, and it furthermore allows for evidence-based policymaking (CAO 2021, 58). Moreover, in order to support the cooperative use of data within the private firm sector, the Connected Industries initiative encourages data sharing through promoting the establishment of a data request system, in which businesses can request industry

data held by the government (METI 2017, 30). By establishing a certification system for data sharing businesses, the government can ensure the legitimacy of data cooperation projects between private sector organizations (METI 2017, 30). To provide support to companies in adapting to data sharing activities, the Connected Industries initiative also sets out to offer advice and on-site inspections to firms (METI 2017, 30).

Abenomics framework, as an important factor in driving forward efforts towards realizing Society 5.0, suggests opening up government data, specifically in areas such as energy, mobility, healthcare or agriculture, to support the innovation of products and services (JapanGov 2020, 7). In this context, the framework also advocates for openly providing geospatial data to support the development of new business ideas (JapanGov 2020, 7).

Provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations

The basic plan intends to build an environment within which data can be linked and shared among all fields and sectors, including researchers and startups (CAO 2021, 18), identifying this effort as an important aspect of their university funding strategy (CAO 2021, 63), which I will elaborate on later. Through what is being referred to as a "data ecosystem", the basic plan sets out to build an infrastructure system within which research data can be accessed and distributed across all fields (CAO 2021, 19-20). With the Data Society Alliance (DSA), an organization established in late 2020 to promote the distribution of data within society, at the center, the fusion of data infrastructures of all research fields as well as with smart city environments are being promoted as a means of creating a platform for data collaboration (CAO 2021, 19-20). With the government acting as a "data holder", the basic plan states an intent to further scale data collaboration and data distribution by applying AI technologies and allowing for international data exchange (CAO 2021, 19-20). Aiming to provide organizations and strategies to build cyberspace, the basic plan sets out to install a digital agency with the function of supervising and maintaining information systems on both national and local levels (CAO 2021, 19). It further plans to review regulations in pursuit of allowing for a "digital society" to develop, as well as to clarify the rules regarding the use of data and cyberspace applying to the private and public sectors (CAO 2021, 19). In the pursuit of open innovation, the basic plan states the importance of fostering openness and agility within the developed technologies when supporting corporate innovation activities (CAO 2021, 33-4). The plan further sets out to establish open innovation bases, which allow both public and private stakeholders to collaborate

in their innovation efforts, and announces the establishment of a project management system supporting sustainable, qualitative, and open collaboration between academia, government, and the private sector (CAO 2021, 34). The intent to continue to develop a large-scale system allowing for the collaboration between government, academia, and industry based on the concept of comprehensive knowledge is also being stated (CAO 2021, 43).

As a specific infrastructure project to support research and data exchange within academia, the basic plan promotes the development of the ultra-high-speed and large-capacity *Science Information Network* (SINET) (CAO 2021, 59), a communication and information system designed and operated by the National Institute of Informatics (NII), which functions as a country-wide academic information hub for R&D laboratories and universities (CAO 2021, 20). The SINET research data exchange system is emphasized by the basic plan as a measure to improve communication between research organizations, as well as to foster exchange of research data among universities and other R&D institutions (CAO 2021, 59). The basic plan promotes the co-creation of knowledge through cooperation across all levels of public and private entities, and, in a bottom-up approach, aims to create an environment in which actors across government, industry, and academia are encouraged to participate in innovation and technology policy formation processes (CAO 2021, 59).

Aiming to build a global research data collaboration platform and to enhance international data interoperability, the basic plan promotes cooperation with other countries through utilizing Japan's research data infrastructure system (CAO 2021, 58). As another aspect of technology diplomacy, the basic plan identifies the international dissemination of information regarding issues such as the realization of Society 5.0 (CAO 2021, 44). Through utilizing abroad institutions like diplomatic agencies or foreign-based R&D institutes, the basic plan proposes to strategically develop technology diplomacy by actively disseminating relevant information (CAO 2021, 44).

In order to maximize results of the previously mentioned joint research strategies, as well as to allow universities to boost their research potential and respond more flexibly to academic developments, the basic plan promotes networking activities of national universities through joint research centers (CAO 2021, 52). To further boost international cooperation around issues regarding global change, the basic plan suggests bolstering the functions of global innovation research centers, as well as to enable them to partake in transnational exchange (CAO 2021, 24).

Management contracts between private & public organizations, public-private partnership

To encourage innovation at the grass-roots level, the Abenomics framework sets out to utilize public-private schemes to improve the new startup ecosystem (JapanGov 2020, 14). By making use of such partnerships between the private and public sector, like the J-Startup initiative, the program puts forward a plan to develop "as many as 20 unicorns by 2023" (JapanGov 2020, 14). Furthermore, aiming to increase international cooperation, the Abenomics framework suggests bolstering competitiveness by supporting public-private cooperation, specifically when collaborating with partner countries (JapanGov 2020, 12).

Under the guidance of the DSA, the data strategies outlined by the basic plan also aim at utilizing data collaboration networks to allow for the creation of public-private collaboration platforms (CAO 2021, 19-20). Through building a data interface that is open to both public and private stakeholders, the plan looks to promote public-private partnerships that aim at creating value and simultaneously have the capacity to solve regional issues (CAO 2021, 38). Based on the SINET research data exchange platform, the basic plan considers improving the environment for exchange of data between the public and the private sectors, identifying it as a potential part of Japan's overall social infrastructure by making academic knowledge available to organizations outside the public R&D sphere (CAO 2021, 59). In addition, the basic plan also identifies the smart city concept as a platform to drive cooperation between the public and private sectors, as it allows for easy data exchange within as well as between regions across the country (CAO 2021, 38).

Establishment of technology transfer alliances between research organizations, provision of knowledge networks & knowledge markets

Regarding this policy instrument, no strategies could be identified within the Japanese policy frameworks assessed.

4.4.2 Korea

Capacity building, promoting technology improvement, provision of access to testing facilities, incubation activities, provision of technology expertise & consultancy services, enable commercialization of innovation through technical & financial support, awareness-raising

Aiming to accelerate industrial innovation through targeting certain economic platforms, the Growth through Innovation initiative promotes a reorganization towards the "3+1 strategic

investment fields", a term which refers to the areas of Data, 5G network, AI, as well as the hydrogen economy (MOEF 2019, 10). As part of this strategy, the initiative sets out to offer support to private enterprises specifically in conducting R&D of next-generation AI by promoting large-scale development projects to overcome the current limitations of AI technology (MOEF 2019, 11). To do so, the provision of innovation support centers is being stated, which are to support firms' self-sufficiency in technology fields such as robotics, image processing, or autonomous driving (MOEF 2019, 12). In order to actively boost innovative growth in the industry sector through strategic investment, the Growth through Innovation strategy also identifies a number of key technology areas that possess a crucial impact on innovation, and have the potential of effectuating a global competitive advantage: Firstly, the fields data, network, and AI (D.N.A.) are being promoted as a means of achieving integration and convergence across all industries, as well as being production factors essential in the era of the FIR (MOEF 2019, 22). Secondly, the areas semiconductors, integrated healthcare, and future cars (BIG3) are being recognized as fields with high growth potential and in which, through appropriate investment, a leading global market position can be achieved (MOEF 2019, 22). Through utilizing a ripple effect strategy, the initiative intends to promote these fields by concentrating resources in those areas, aiming to initiate a domino chain in which large-scale financial support to the D.N.A. and BIG3 fields will spread innovative growth across all industries (MOEF 2019, 22). According to the I-Korea 4.0 initiative, the technology fields in which capacity needs to be built in order to assure competitiveness in the FIR are basic technologies, such as materials or basic data and AI capacities, intelligent technologies, such as next generation learning or nano devices, and convergence-based technologies, which merge fields such as AI and robotics with each other (MSIT 2017, 62-4). To cultivate and nurture innovative growth engine technologies for the FIR, the initiative sets out to create the conditions for early commercialization through providing public investment in R&D, through granting market access by promoting demonstration projects in collaboration with strategic industries, as well as by supporting the creation of demand, which I will elaborate on in a subsequent section (MSIT 2017, 65-6). The technology areas identified as growth engines include big data, AI, autonomous vehicles, intelligent robots and drones, virtual and augmented reality, next-generation communication services, smart city, customized healthcare, advanced materials, intelligent semiconductors, innovative new drugs, and new and renewable energy sources (MSIT 2017, 65).

Measures stated by the Growth through Innovation Initiative to support companies in improving their levels of commercialization and productivity in order to raise demand for their

products and services include support in localizing core R&D equipment, allowing for the participation in demonstration projects, and, more generally, providing support to existing companies in adapting to the future market (MOEF 2019, 15-9). The Growth through Innovation initiative advocates for the support of businesses through planning packages targeting demonstration and commercialization of new technologies and services (MOEF 2019, 21). By facilitating convergence among fields of innovative growth, the initiative sets out to support firms in verifying usability prior to commercialization, in conducting product planning based on existing research, and in developing business models that will pave the way to commercialization (MOEF 2019, 21). With the goal of establishing a cyber security industrial ecosystem, the Digital New Deal promotes commercialization of technologies in areas like blockchain, AI security systems, or 5G network security by supporting the evaluation of their performance, as well as by allowing for demonstration and testing within safe environments such as security living labs (MOEF 2020a, 54). To further support the development of technology in the cybersecurity field, the Digital New Deal advocates for giving support to businesses in obtaining certifications verifying product safety, particularly in the field of IoT and mobile apps, suggesting facilitating access to testing by verified agencies (MOEF 2020a, 55). As a means of supporting the growth of SMEs and startups, the I-Korea 4.0 initiative promotes the provision of dedicated demonstration and commercialization special zones, within which regulations are temporarily eased, giving new businesses the opportunity to test run new FIR technologies, products, and services that are not yet clearly regulated (MSIT 2017, 76). This approach is meant to give businesses the chance to conduct testing and demonstration in a safe environment, while the government can evaluate if current regulations apply, or whether regulatory adjustments need to be made in order to proceed with commercialization (MSIT 2017, 76). To further support the growth of local FIR businesses specifically, the I-Korea 4.0 response plan suggests giving local governments the authority to select clusters which are then provided with support in the form of large-scale industry demonstration spaces (MSIT 2017, 76). The Growth through Innovation initiative advocates for the provision of a smart city sandbox environment to innovative firms, within which new business models can be discovered and new products and services can be demonstrated, identifying it as a means of boosting new convergence technologies by providing an open platform for their development (MOEF 2019, 17). With the aim of transforming existing urban areas into highly efficient cities through smartization, the PCFIR, too, promotes the development of a national smart city model, suggesting bolstering its implementation through public-private planning efforts, as well as by establishing cooperative governance across ministries in the form of a smart city promotion committee (PCFIR 2019, 67-8).

Through increasing the development of AI infrastructure in existing cities, and by promoting the fostering of smart solutions in urban areas, the Growth through Innovation initiative also aims to facilitate the use of demonstration smart city environments to enhance R&D capacities (MOEF 2019, 17). Furthermore, by establishing a Korean smart city model, the international expansion of the smart city concept is also being advocated for (MOEF 2019, 18). On a similar note, considering Korea's competitive advantage due to the large well of experience in the urban development and ICT fields, the PCFIR suggests creating an overseas expansion strategy of the Korean smart city model based on collaboration among related institutions and enterprises, with a focus on Southeast Asia, the Middle East, and Africa, regions within which a high demand for smart city solutions is being identified (PCFIR 2019, 68).

Aiming to support the development of intelligent healthcare, as well as to secure international competitiveness in the field, the I-Korea initiative advocates for introducing a drug development ecosystem within which, through utilizing AI and big data technology, drug development cycles are shortened and overall development costs are reduced (MSIT 2017, 38). The initiative also advocates for supporting the medical device industry by providing access to public R&D in the smart convergence medical device field, allowing for the acceleration of development, licensing, and commercialization processes (MSIT 2017, 38). With the goal of enabling commercialization of AI technologies, the Digital New Deal framework promotes the public demonstration of commercialization services in the manufacturing robotics field by providing the necessary demonstration equipment for each specific type of robot (MOEF 2020a, 44). The PCFIR suggests expanding the smart factory ecosystem by establishing evaluation and monitoring systems, as well as by enabling the spread throughout the private sector by providing reliable success models (PCFIR 2019, 61). On a similar note, the I-Korea 4.0 response plan proposes to increase the number of model smart factories across all relevant sectors, such as automobile or electronics, and to extend support in developing smart factory maintenance systems, utilizing sensor and cloud technologies (MSIT 2017, 39-40). The response plan also sets out to publicly promote 3D printing technology by providing implementation support and service demonstrations, and to bolster the use of intelligent manufacturing robots by further supporting the development and commercialization of robotics core technologies (MSIT 2017, 40). In order to support digital innovation processes in the manufacturing field, the Digital New Deal suggests utilizing the existing smart industrial complex for testing activities, setting out to establish simulation centers for production processes, as well as to create a demo factory to demonstrate and validate manufacturing technology (MOEF 2020a, 75). Aiming to increase

competitiveness and sustainability of the agriculture industry by utilizing smart technologies, the I-Korea 4.0 initiative sets out to provide smart farm testing environments that include production and distribution functions (MSIT 2017, 46). To boost the use of AI in the food production sector, the framework advocates for supporting the digitization of agriculture by allowing for field demonstrations on state-of-the art smart agricultural production sites, as well as the improvement of smart aquaculture by establishing farming clusters that support testing, development, and distribution processes (MOEF 2020a, 44). Aiming to allow for industry testing activities around technology for automated and unmanned agricultural production, the committee suggests establishing an unmanned agriculture and fishery production complex (PCFIR 2019, 66). In order to further support the development in the smart logistics field, the I-Korea 4.0 response plan suggests further promoting commercialization efforts through providing technology test beds (MSIT 2017, 45). In addition, to promote R&D processes in the field of advanced logistics systems, the Digital New Deal sets out to create seventeen digital logistics demonstration cities, within which smart logistics approaches, such as solutions that are based on robotics or big data technologies, can be illustrated (MOEF 2020a, 78). Aiming to support innovative activities in the mobility industry, the I-Korea 4.0 response plan promotes the establishment of public test sites for autonomous vehicles and drones (MSIT 2017, 42-3). In order to facilitate commercialization in the autonomous mobility sector, the Digital New Deal framework promotes the improvement of related test beds, as well as the public demonstration of autonomous driving technologies, such as shuttle busses and delivery services (MOEF 2020a, 43). Caused by a lack of provision of scientific information on the value of advancements in new bio-health technologies, the PCFIR points out an ongoing controversy among the public regarding issues such as leakage of personal data, healthcare privatization, or increase of medical expenses (PCFIR 2019, 60). In order to ease those fears towards changes in the bio-health industry, the committee promotes efforts to raise public awareness on the achievements of new technologies and services in the bio-health sector, suggesting creating a better understanding of their benefits to society by communicating them publicly (PCFIR 2019, 60).

With the goal of aiding the development of new growth engines, such as source technologies and innovation process technologies, the Growth through Innovation initiative sets out to improve SME competitiveness by providing customized technology development support, as well as by assisting them with smart factory construction (MOEF 2019, 27). The project outlined to facilitate this support aims at enabling SMEs in conducting R&D that secures productivity advantage, and to tailor processes to the size and capabilities of the respective enterprise

(MOEF 2019, 27). In order to allow small businesses to transition towards smart management approaches, the Digital New Deal promotes the establishment of 10.000 smart workshops, through which basic smart technologies, such as automation processes, are being introduced to business owners (MOEF 2020a, 68). Aiming to support the development of online sales in the SME sector, the Digital New Deal framework suggests to widely provide product improvement consulting to small business owners (MOEF 2020a, 67). To allow private businesses to engage in the creation of smart logistics facilities, the Digital New Deal strategy proposes to provide administrative support for the conception and planning of advanced logistics facilities, as well as maintenance support for certified smart logistics locations (MOEF 2020a, 76). With the intend to support remote and contact-free working styles in the SME sector, the Digital New Deal also advocates for providing services and consultation for implementing remote work solutions to 160.000 SMEs (MOEF 2020a, 65). Setting out to foster a startup ecosystem in the field of agriculture and fishery specifically, the PCFIR promotes the creation of networks enabling the interconnection of agricultural and fishery technology suppliers, financial institutions, and experts in the field (PCFIR 2019, 66-7). The committee further promotes improving support for technology evaluation, aiming to bolster external financing of innovative technologies in the food production sector (PCFIR 2019, 67).

By expanding the openness of public data, improving its quality, and promoting its commercial utilization, the Growth through Innovation initiative sets out to bolster the development of new industries (MOEF 2019, 37). Aiming to support customized commercialization efforts of new businesses, the initiative specifically proposes to enhance the accessibility of digitized and accumulated geographical data, to improve the quality of spatial information, as well as to provide public access to construction project information (MOEF 2019, 37-8). In order to bolster the data industry and to support data-based services, the Digital New Deal approach sets out to open public data to private use by establishing an integrated big data platform connecting all public institutions (MOEF 2020a, 39). Furthermore, aiming to expand the number of existing industry specific data platforms, big data is to be actively collected and analyzed, and its accessibility and usability is to be improved (MOEF 2020a, 41). Moreover, with the aim of bolstering the development of smart industry processes, the Digital New Deal sets out to further construct and improve the smart industrial complex by establishing two data centers providing solutions around areas such as process optimization and quality management, by expanding the integrated control centers for logistics and safety support, as well as through implementing remote monitoring systems using AI, drones and sensors to prevent accidents (MOEF 2020a,

75). To induce system improvement in the industry sector, specifically for SMEs, the Digital New Deal framework promotes the provision of an industry cloud infrastructure, which is being identified as a crucial solution in areas such as manufacturing, healthcare, logistics, or education (MOEF 2020a, 49). On the same note, the Growth through Innovation initiative aims to provide cloud infrastructure and services to SMEs and start-ups (MOEF 2019, 11). Aiming to bolster remote and contact-free work styles among SMEs, the Digital New Deal framework advocates for the establishment of video conference facilities that can be freely used by businesses across the country (MOEF 2020a, 65). In order to further improve the quality of remote work in SMEs, the framework promotes the provision of advanced technologies in areas such as video conference quality improvement, remote business management and collaboration, or remote access security (MOEF 2020a, 66). As a means of backing SME online business, the Digital New Deal framework suggests aiding the development of online sales channels by providing support to small business owners around areas such as e-commerce, online exhibitions, or live commerce (MOEF 2020a, 67). Furthermore, the implementation of subscription economy pilot projects is being promoted, aiming to provide small businesses with a stable online marketplace (MOEF 2020a, 67). To further bolster the smartization of the SME sector, the Digital New Deal framework suggests supporting the establishment of smart stores, which utilize contact free order and payment systems such as service robots and QR codes (MOEF 2020a, 68). In addition, the framework sets out to provide small business owners with access to commercial information systems, which support sales forecasting and marketing activities through AI-based analysis of factors such as location, consumption trends, or demographics (MOEF 2020a, 68). With the aim of modernizing food production by creating an intelligent agricultural and fishery industry framework, the PCFIR promotes the creation of a digitized information system which provides information on agricultural attributes of land, spatial information, and ecological information, as well as to accumulate production data for automated and unmanned agricultural production projects within the previously mentioned agriculture and fishery production complex (PCFIR 2019, 66). Aiming to further support the development of the agriculture industry, as well as to increase sustainability, the I-Korea 4.0 response plan promotes the development of management systems for growth information and yield prediction (MSIT 2017, 46). As far as the innovation of the fishery sector goes, the response plan suggests giving the industry access to automated environmental monitoring and fishery resource management systems, as well as to publicly provide smart aquaculture technology, such as intelligent filtration systems, to the private sector (MSIT 2017, 46-7). To further drive forward automation in the food production sector, particularly in light of the industry's workforce decrease,

the response plan promotes the provision of easy access to automation technologies, such as farming or marine robots, to support food distribution by implementing distribution systems based on big data, and to mitigate the risk of natural disasters by providing intelligent warning and forecasting systems (MSIT 2017, 47-8).

Improve accessibility of scientific data through open science, generate spillovers, interlinking of different research fields

In order to promote technology development by fostering the convergence between industries, the Growth through Innovation initiative sets out to establish and operate a research data platform on a national basis, aiming to support data-driven approaches towards innovation (MOEF 2019, 20). The platform is meant to support users in finding, analyzing, sharing, collecting, managing, and using research data, as well as to provide users with information on researchers through integrating with the National Science & Technology Information Service (MOEF 2019, 20). Aiming to bolster R&D systems, the I-Korea initiative, too, promotes open innovation through institutionalizing the spreading and use of research data through the establishment of a national open research data platform (MSIT 2017, 67). The cloud-based platform is to give individual researchers access to various research areas which are being gradually expanded, and algorithms are to be applied to support AI-based R&D (MSIT 2017, 67). To realize its introduction, the initiative advocates for adjusting legislation around research data sharing and utilization, and to introduce a data management plan, aiming to also open the platform to startups and developers in the future (MSIT 2017, 67). Furthermore, in order to grant researchers and students open access to scientific information, the Digital New Deal framework proposes to provide online access to a knowledge platform containing public and publicly held publications (MOEF 2020a, 49). Additionally, through this platform subscriptions to international academic journals are to be expanded (MOEF 2020a, 49).

Provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations

As a means of improving commercialization of bio-health R&D, the PCFIR identifies the need to create an industrial ecosystem to commercialize research results (PCFIR 2019, 60). To that end, the committees suggest connecting basic research to the clinical stage by creating an infrastructure supporting intermediary research, therewith bolstering the commercialization of new products and technologies (PCFIR 2019, 60). In addition, the PCFIR promotes the induction of a virtuous cycle of privately led industrial ecosystems through improving systems and

infrastructure, aiming to create an environment in which medical institutions serve as a hub for R&D cooperation in the bio-health sector (PCFIR 2019, 60). In order to enable innovative activities in line with the constantly changing manufacturing environment, the PCFIR advocates for close cooperation between all actors of innovation, including both industry and academia (PCFIR 2019, 61). To realize this, the committee suggests establishing a horizontal open cooperation network within which various innovators can participate, and which gathers their contributions, allowing for joint R&D activities (PCFIR 2019, 61). To improve production capacities, the PCFIR identifies the need to establish a national big data ecosystem through which data related to manufacturing is opened to the industry sector, specifically catering to the needs of SMEs, which have fewer capacities to build manufacturing data (PCFIR 2019, 62). To achieve this, the committee promotes the creation of a public cloud-based manufacturing big data platform, suggesting providing government support in founding a domestic big data ecosystem, as well as in maintaining it and in ensuring data security (PCFIR 2019, 62). Aiming to aid the innovation of financial processes, the PCFIR also promotes the creation of a data ecosystem enabling both private and public actors to share financial data (PCFIR 2019, 63). As an important aspect in creating such a platform, which would allow for increased data utilization, the committee emphasizes the importance of protecting personal information through strengthening user rights and related institutions (PCFIR 2019, 63).

Specifically aiming to enable the fostering of startups and promising startup technologies, the response plan promotes the creation and revitalization of research spin-offs by strengthening customized public support across all stages of growth, by establishing affiliations with universities, and by easing regulatory establishment requirements (MSIT 2017, 68). In order to allow for the bolstering of SMEs through enabling industry-academia cooperation, the I-Korea 4.0 initiative advocates for the establishment of science and technology-based clusters within which R&D support can be provided by universities, and through which exchange can take place around areas such as technology information, manpower, or investment (MSIT 2017, 76). To this end, the initiative suggests creating R&D bases that connect universities and other research institutes with SMEs, aiming to establish industry-academia networks that allow for joint research activities (MSIT 2017, 76). With the aim of establishing regional hubs of industry-academia cooperation, the Growth through Innovation initiative promotes dedicating spaces on university campuses to be used as such that enable collaboration between businesses and academia (MOEF 2019, 24). The initiative advocates for the reorganization of otherwise unused university facilities to high-tech industrial complexes that can be occupied by private

sector firms (MOEF 2019, 25). Within those spaces, businesses can receive support in resolving industrial difficulties through cooperation with the respective host universities (MOEF 2019, 25).

Management contracts between private & public organizations, public-private partnership

In order to regulate data trading, the 3+1 strategic investment fields strategy also sets out to establish a system allowing for public-private cooperation in using big data platforms (MOEF 2019, 10). The Growth through Innovation initiative aims to ensure safe and systematic data use through instituting a consultative chain called the "Big Data Alliance", which consists of representatives from the big data platforms as well as public officials, deciding on aspects regarding quality, policies, distribution, and performance management regarding data sharing (MOEF 2019, 10). Based on the revision of the "3rd Data Act", which improved regulations regarding the protection of personal data, network data, and credit information, the 3+1 strategic investment fields strategy also aims to promote the extension of accumulated data use, supporting full-scale data usability in the industry sector (MOEF 2019, 10). To further promote public-private partnerships through big data collaboration, the Growth through Innovation initiative seeks to promote data transaction by establishing processes regarding the linking between data platforms, and the securing of data standards and quality (MOEF 2019, 11). Furthermore, the initiative aims to establish safe data use between public and private actors by providing transaction guidelines and standard contracts (MOEF 2019, 11).

Establishment of technology transfer alliances between research organizations, provision of knowledge networks & knowledge markets

By building an open innovation platform and network, the Growth through Innovation initiative aims to establish a discussion space for academia and industry actors to design strategies regarding innovation of smart services, which combine both data as well as digital technology (MOEF 2019, 26). Through this organic network of experts from various fields, the initiative aims to allow for the design of future industries, while fostering innovative growth by providing a platform for open innovation (MOEF 2019, 26). Furthermore, this network is also to be used as a means of conducting crowdsourcing for technology demands of SMEs, as well as to connect factory-less manufacturers with firms specializing in manufacturing (MOEF 2019, 26). To further strengthen the foundation of convergent technology development approaches, the Growth through Innovation initiative aims to provide access to an open application programming interface (API) to businesses, which allows firms to acquire data from outside

organizations, individuals, as well as public sector data (MOEF 2019, 20). Through widening the open API environment, the initiative intends to promote data utilization and distribution among businesses, improving convergence between them, and to spur competition (MOEF 2019, 20). With the goal of strengthening data generation and data sharing processes, the I-Korea 4.0 initiative promotes the establishment of a national big data support system across all areas of industry (MSIT 2017, 70). To realize this, the initiative advocates for establishing specialized data centers that support the creation and evaluation of big data in the public and private sectors, as well as the introduction of a public open data platform which collects and manages government data (MSIT 2017, 70). To openly provide new industry core data, the initiative suggests undertaking adjustments in areas surrounding data standardization and integration, security standards, as well as to modify regulations on data collection, particularly those protecting personal data (MSIT 2017, 70). Ultimately, this strategy aims to improve the utilization and diffusion of accumulated data, creating an environment in which businesses can improve their innovation activities through data-based operations (MSIT 2017, 70).

With the goal of activating technology transfer and commercialization, the Growth through Innovation initiative aims to widen the scope of support for industrial transfer and commercialization of technologies and patents owned by universities (MOEF 2019, 24). The initiative sets out to strengthen commercialization efforts by initiating a creative asset commercialization project, which supports technology transfer from universities in areas such as technology discovery, prototype production, or the design of business models (MOEF 2019, 24). Furthermore, the initiative seeks to revitalize university technology holding companies through providing direct support to their subsidiaries in commercializing technology, as well as through allowing for better investment recovery by relaxing regulations regarding minimal stock ownership (MOEF 2019, 24). The PCFIR promotes increased public support for establishing a platform that allows for the creation of innovative products and services through data and resource sharing across the manufacturing value chain (PCFIR 2019, 62). To that end, the committee proposes to enable the linking of core competencies, and for the government to implement a platform allowing private sector participants to conduct planning, evaluation, investment, and technology transfer processes (PCFIR 2019, 62).

4.5 Human Capital and Skill Development

4.5.1 Japan

Regulation / organization / funding of national education system

The Abenomics framework advocates to "make education more practical" by nationally adjusting higher education curricula and teaching materials to better equip graduates with the skills required in modern professions, specifically mentioning the areas of IT, AI, mathematics, and data science (JapanGov 2020, 8). Additionally, the framework suggests the introduction of programming as a mandatory subject from elementary school level to enhance IT literacy (JapanGov 2020, 8). To promote the digital transformation in the education sector, the basic plan advocates for allocating more HR with ICT backgrounds to the education field, as well as to actively utilize educational data generated through daily learning processes (CAO 2021, 69). Utilizing such data can help students to better reflect on their learning progress and improve teaching efforts by optimizing teaching and guidance methods (CAO 2021, 69). To streamline those learning methods and to allow for policy planning in this regard, the basic plan further intends to publish a new education data standard by the end of 2021 (CAO 2021, 69). Furthermore, an integrated school affairs support system is stated to be introduced by 2022, with the goal of reducing the workload of teachers (CAO 2021, 70).

By utilizing a cross-curricular education approach encompassing the fields of science, technology, engineering, art, and mathematics, abbreviated as STEAM education (CAO 2021, 12), the basic plan sets out to strengthen the development of scientific skills among high school students (CAO 2021, 68). With the goal of enhancing learning activities, the basic plan aims to fully implement new guidelines for high school curricula based on the STEAM approach by 2022, stating that support will be provided to schools in order to enhance efforts towards their application (CAO 2021, 68). Aiming to expand the reach of the STEAM platform, the basic plan has announced the presentation of a model plan regarding the dissemination of its educational content to elementary and middle schools (CAO 2021, 68-9). Furthermore, the basic plan promotes the utilization of the STEAM platform to provide learning opportunities outside of school, in the form of activities such as training camps held by universities, science contests, or international exchange programs (CAO 2021, 69). The basic plan intends to proactively investigate to what degree such scientific and cross-disciplinary skills are being evaluated in university entrance and employment processes, aiming to tally the number of universities and firms considering this aspect of education and to announce it in 2022 (CAO 2021, 69).

With the goal of enabling the development of diverse HR in universities and technical colleges, the basic plan intends to allow for the provision of curricula that support students' self-actualization based on individual values (CAO 2021, 71). By conducting a long-term analysis of the factors deciding whether students are able to do so, the basic pan sets out to then allow for a more appropriate selection of university, as well as a more individual choice of coursework for students (CAO 2021, 71). The basic plan's university funding strategy, which was previously outlined, also encompasses the support of developing new HR within public universities (CAO 2021, 63).

Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing

Specific strategic approaches towards the areas vocational training, on-the-job training, apprenticeships, or learning by doing were not mentioned within the policy approaches provided by the Japanese government.

Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators

Aiming to foster management personnel within innovative small businesses, the basic plan states the intent to create an environment that incentivizes managers who have the necessary requirements to take on leading positions within startups (CAO 2021, 33). To develop HR that can proactively create value through innovation, the basic plan sets out to utilize the startup ecosystem to bolster managerial capacities through providing entrepreneurship programs across the country by 2025 (CAO 2021, 34). As measures to improve the level of HR expertise within SMEs and regional businesses, the Connected Industries initiative promotes HR training and capacity building processes through collaboration with various private and public sector organizations, such as local business accelerators or national technology promotion initiatives (METI 2017, 36). By supporting companies in developing experts, providing training curricula, or assigning external personnel, the initiative seeks to support businesses in increasing their added value and improving their productivity in line with the FIR (METI 2017, 36). The goal of this scheme is to foster leadership and to enable target companies to streamline operational processes, introduce modern business technologies, combat labor shortages, and pass on technical expertise to coming generations (METI 2017, 36).

Focusing broader humanitarian education / multi- & interdisciplinarity / lifelong learning / technical literacy

Aiming to promote the development of career paths that meet societal needs, based on the comprehensive knowledge strategy, the basic plan sets out to work towards implementing a graduate education reform that supports the development of HR with knowledge in the fields of social sciences and humanities (CAO 2021, 54). The basic plan also encourages to adjust undergraduate degree programs towards having more versatile curricula, allowing for course-work outside their home faculties, as well as for the acquisition of double major degrees (CAO 2021, 71). This is particularly aimed at allowing for the addition of liberal arts education into other majors, while still enabling students to work towards a specialized graduate education (CAO 2021, 71). Another method put forward by the basic plan to promote multi- and cross-disciplinarity, particularly within secondary and primary education, is the previously mentioned STEAM education approach (CAO 2021, 68-9). The basic plan states that, besides its application in pre-tertiary education, this approach also has the potential to foster learning activities for society as a whole, as it can be utilized to accelerate specific educational efforts towards realizing Society 5.0 (CAO 2021, 69).

As part of their HR development strategy, the Abenomics framework suggests bolstering support for additional education throughout peoples' lives (JapanGov 2020, 8). The framework mentions support for people who look to boost their skills, as well as specifically for those individuals who aim to change jobs (JapanGov 2020, 8). It also sets out to support mothers who reenter the workforce after maternity leave, wishing to increase their skill level or change occupation, with further education (JapanGov 2020, 8). Aiming to foster an environment that promotes continuous learning, the basic plan advocates for creating a system that encourages individuals to maximize their abilities through re-learning (CAO 2021, 70). The basic plan states that relevant ministries and public agencies are to jointly consider concrete efforts contributing to continued learning by individuals, particularly around the topics of introducing recurrent education for employees within firms, as well as the utilization of an educational leave system (CAO 2021, 70). Furthermore, use of digital content is being brought forth as a measure to widen recurrent education programs, such as open online courses that allow participants to acquire certificates upon completion (CAO 2021, 71). The basic plan intends to incentivize universities to engage in digital continuous education, considering putting in place mechanisms allowing for flexible hybrid education approaches conducted both online and face-to-face (CAO 2021, 71). To incentivize companies to provide their employees with the

opportunity for sabbatical leave and financial support of continuous education, the basic plan suggests recognizing such businesses as leaders in the field of HR development, and to implement measures leading to an improvement of their corporate image (CAO 2021, 70). Similarly, based on their strengths and regional issues, universities are being encouraged to dedicate themselves to supporting recurrent education (CAO 2021, 71). The basic plan sets out to develop an index evaluating the number of working individuals in recurrent education, as well as the effectiveness of those measures and their impact on society overall (CAO 2021, 70).

As pointed out above, the Abenomics framework advocates for changing the higher education curriculum towards emphasizing the development of skills around areas such as AI, data science, IT, and mathematics, as well as for fostering IT literacy from elementary school level onwards (JapanGov 2020, 8). The Connected Industries initiative promotes the development of "hybrid" HR, who possess expertise in both the virtual and the physical worlds (METI 2017, 35). The initiative hereby specifically refers to individuals that either have expertise in IoT, or such that are able to utilize advanced technologies, such as AI or big data, while also being familiar with processes on the factory floor (METI 2017, 35). While surveying the industry's precise HR demands in this field, the Connected Industries initiative, in cooperation with other public sector actors, sets out to support the private sector in training and fostering hybrid personnel, and to build HR capacity across those technology fields (METI 2017, 35).

Preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation

In order to support women in the workplace, the framework intends to provide leadership training programs held by leading business scholars to female workers (JapanGov 2020, 9). It further proposes to promote paternity leave and to encourage men to take a more active role in domestic activities, while also making sure to extend assistance to single parents, both female and male ones (JapanGov 2020, 9). For women reentering the workplace after maternity leave, as already mentioned above, additional education in preparation of their new tasks is to be provided (JapanGov 2020, 9). On a more general note, the framework also mentions the improvement of health care for women, as well as the elimination of crime against women, such as domestic violence, sex crimes, sexual harassment, human trafficking or stalking (JapanGov 2020, 9). Attempting to diversify HR within universities and other public research institutes, the basic plan sets out to promote the participation of female students and researchers in fields

related to natural sciences and engineering, through laying out clear career paths to high school students and by introducing them to female role models in those fields (CAO 2021, 51). The plan also proposes to set strategic targets for those institutions to account for the ratio of female doctoral students enrolled in each field (CAO 2021, 51). Furthermore, improving the environment and support system for women in academia is an integral part of the basic plan's objective to promote the active participation of female researchers, which his to be facilitated by adjusting regulations regarding maternity leave, establishing on-campus childcare facilities, and through promoting overall family-friendly workplace reforms (CAO 2021, 51).

Aiming to empower senior citizens, the Abenomics framework sets out to provide the opportunity for employees to work beyond their official retirement age on an optional basis, as well as to back firms that intend to retain staff above retirement age (JapanGov 2020, 9). The framework also states the possibility of making efforts by companies to secure employment opportunities for staff of up to 70 years of age compulsory (JapanGov 2020, 9). Furthermore, it is being stated that support in matching senior applicants with viable job opportunities is to be provided, and that considerations need to be made regarding raising the retirement age for civil servants from 60 to 65 years (JapanGov 2020, 9). To further increase diversity and the empowerment of people in pursuit of realizing Society 5.0, the Abenomics framework proposes to move toward providing free education for members of low-income households, from early childhood until higher education (JapanGov 2020, 8) In addition, it also suggests increasing the availability of scholarships that do not require to be repaid (JapanGov 2020, 8).

In order to improve the situation of research personnel at universities, specifically that of doctoral students, the basic plan sets out to enhance research fellowship systems, expand support given through scholarships, as well as to apply tuition reductions (CAO 2021, 49-50). With the aim of allowing research assistants to develop sustainably and to play a more active role in universities, the basic plan also aims to formulate regulations putting in place a framework for appropriate salary payments, to encourage fixed-term employment schemes, and to promote the use of clear standards in the form of a tenure track system and transparent rules regarding doctoral degree examinations (CAO 2021, 49-50). In order to better match doctoral degree holders to jobs outside of academia, the basic plan proposes to clarify the academic needs for civil servants, and to place degree holders in public positions based on their educational background (CAO 2021, 50). As far as matching with the private sector goes, the basic plan's approach revolves around supporting industry-academia collaboration, which I will elaborate on in one of the subsequent sections (CAO 2021, 50). To improve mobility of

research personnel between the industry sector and universities, as already touched upon in the previous section, the basic plan sets out to provide guidelines strengthening research collaboration, focusing on areas such as cross-appointment and side job systems, risk management, as well as the relaxation of organizational rules (CAO 2021, 70).

To improve HR mobility and opportunities for career advancement and career change, the basic plan intends to conduct a survey evaluating current HR development regimes, as well as to disseminate best practices (CAO 2021, 70). Aiming to enhance the quality of innovation creation personnel by increasing HR mobility, the basic plan sets out to improve the provision of information regarding career advancement through online channels, as well as to increase capacities of career consultants, enabling individuals to undertake career changes more easily (CAO 2021, 70).

In an attempt at facilitating a "work-style reform", the Abenomics framework calls for regulations and guidelines to achieve equal pay for equal work, by which it means the removal of inequality in labor conditions between regular and non-regular employees (JapanGov 2020, 8). The framework also promotes a "flexible work style" by allowing employees to work remotely, as well as to work multiple jobs simultaneously (JapanGov 2020, 8). Aim of these policy measures is to implement rules and guidelines that can guarantee the fair evaluation of workers, and to improve motivation (JapanGov 2020, 8).

Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility

Through simplifying visa procedures, the Abenomics framework attempts to attract foreign professionals who possess expertise and work experience in certain fields (JapanGov 2020, 9). The measures mentioned to facilitate this are shortening visa screening duration through fast-tracking, allowing for online application, as well as to initiate a Japanese Green Card program for highly skilled overseas professionals within certain fields (JapanGov 2020, 9). The framework additionally aims to institute a new residence status for foreign workers who have certain levels of technical proficiency and expertise, alongside Japanese language proficiency (JapanGov 2020, 9). It also calls for increasing the number of overseas students and entrepreneurs, and, to further improve the quality of life for foreign nationals in Japan, suggests increasing the availability of international schools, international hospitals, as well as to provide more non-Japanese signage (JapanGov 2020, 9).

Furthermore, in order to build the previously mentioned international research network in Japan, and to both attract overseas research HR as well as to facilitate international mobility,

increased support for the international exchange of research personnel and students is being proposed by the basic plan (CAO 2021, 44). Aiming to attract excellent HR from around the world and to bolster international brain circulation, as already touched upon above, the basic plan is currently working on a strategy to stimulate the hiring of foreign researchers (CAO 2021, 52). The measures proposed to improve international acquisition of research talent include the adjustments of international recruitment and hiring methods, internationalization of research bases, adaptation of salaries and working conditions to international standards, provision of living support to foreign workers and their families, and the internationalization of administrative processes (CAO 2021, 52).

Strengthening support for external competence building, enable HR development through university-industry relations

By encouraging personnel exchange between universities, public R&D institutes, and the private sector, the basic plan aims to bolster the overall efficiency of innovation activities (CAO 2021, 34). Focusing mainly on young researchers, the basic plan sets out to introduce a wide-reaching cross-appointment system between industry and academia by 2023 (CAO 2021, 34). As mentioned previously in connection with bolstering university-industry cooperation, the basic plan has pointed out the exchange of HR from academia with that of the private sector as a means of allowing for continuous learning processes (CAO 2021, 70). To actively promote the implementation of programs directed at facilitating recurrent education in collaboration with non-university institutions, the basic plan intends to provide a framework within which national universities can invest in companies that conduct external training (CAO 2021, 71). In addition to promoting industry-academia schemes supporting recurrent education, the basic plan also sets out to secure the development of specialized HR tasked with designing and coordinating such programs (CAO 2021, 71). To accelerate joint research and education between the firm sector and universities, the basic plan also suggests making efforts towards enabling doctoral HR to expand their career to the industry sector, as well as enabling corporate HR to engage in continued education in academia (CAO 2021, 70). To improve the mobility of individuals between those two sectors, the basic plan further outlines some guidelines to allow for cross-appointment through relaxing organizational rules, which I will elaborate on in the subsequent section (CAO 2021, 70).

With the aim of maximizing recruitment measures and the matching between employees and firms, the basic plan sets out to develop human resources through educational collaborations between the public sector, industry, and academia (CAO 2021, 21). As mentioned above,

the basic plan aims to do so by focusing on methods based on problem-based learning and training programs in the fields relevant to creating HR skills necessary for building a digital society (CAO 2021, 21). Aiming to give researchers enrolled in doctoral programs the opportunity to explore the potential application of their research in the industry sector, the basic plan promotes their participation in industry-academia collaboration activities (CAO 2021, 50). As already touched upon previously, those collaboration efforts are also identified as opportunities to improve recruitment efforts and to match doctoral degree holders to career paths in the private sector (CAO 2021, 50).

In order to support high school students in developing their future careers, the basic plan intends to expand opportunities of cooperative learning with industry, academia, and international organizations (CAO 2021, 70). Through establishing a system of collaboration across the country, collaboration between schools and local industry, universities and transnational organizations is to be established by 2023 (CAO 2021, 70). With the goal of increasing the participation of external HR as a means of improving learning activities in schools, the basic plan promotes projects that allow high school students to come in contact with research activities through collaboration with local universities and R&D businesses (CAO 2021, 69). In order to increase diversity in school education, the basic plan is revising guidelines for certification of external lecturers, aiming to allow experts, such as doctoral degrees holders or experienced people from the private sector, to partake in high school teaching through special licenses and instructor systems (CAO 2021, 69). Specifically targeted at enhancing efforts towards training practical engineers in colleges of technology, the basic plan encourages practitioners from the private sector to participate in their education as teachers (CAO 2021, 71).

4.5.2 Korea

Regulation / organization / funding of national education system

With the goal of cultivating key talent within the intelligent technology field, the I-Korea 4.0 initiative promotes a drastic expansion of educational capacities for HR development around areas such as AI, big data, and cyber security (MSIT 2017, 77). The initiative suggests developing HR both in pursuit of fostering new industries, as well as to support existing major industries, such as displays or ship building (MSIT 2017, 77). By promoting the establishment of an intelligent teaching and learning platform, the I-Korea 4.0 response plan aims to pave the way for a customized learning environment, within which anyone can freely access educational content, and learning processes are being improved by collecting and analyzing learners' big

data (MSIT 2017, 78-9). The response plan suggests that through this platform educational content could be individually provided and customized based on learner level and interest, and an open market for educational contents could be established within it (MSIT 2017, 79). To innovate processes around digital education, the I-Korea 4.0 initiative promotes improving education in the software field by reinforcing educational capabilities among teachers, suggesting to, after assessing current teaching capacities, educate new teachers as well as to provide follow-up education to current teachers in the software field (MSIT 2017, 79-80). To further support digital education, the initiative advocates for providing and distributing digital textbooks that include advanced multimedia utilization methods, such as augmented or virtual reality functions, and for improving wireless infrastructures in educational institutions across the country (MSIT 2017, 79). In the light of likely future changes in manpower demand, the I-Korea 4.0 response plan also advocates for establishing methods to predict shifts in the labor market due to job replacement and technological changes caused by the FIR (MSIT 2017, 80). Through conducting big data analyses of online job postings, the initiative suggests locating changes in sought-after professions as well as in required competencies, which could in a next step, in accordance with the relevant public actors, be utilized to adjust curricula, training schemes and qualification systems (MSIT 2017, 80).

With the goal of shifting the educational focus of primary and secondary education towards core competencies necessary in the future, the PCFIR suggests letting schools act more autonomously in order to be flexible enough to meet new educational demands, be they of intellectual, social or emotional nature (PCFIR 2019, 56). The committee further promotes a comprehensive adjustment of primary and secondary education curricula, aiming to enable students to expand elective courses and to allow for convergence between subjects (PCFIR 2019, 56). To further support educational development, a comprehensive reform of training processes for teachers is also being promoted (PCFIR 2019, 56). The PCFIR states that, in order to enable adjustments reflecting future needs, the government should refrain from taking a top-down educational policy approach, and instead foster innovation within education by establishing a support system, as well as allow for the development of curricula that fit future school models (PCFIR 2019, 56). Aiming to create a digital education system for primary and secondary school levels, the digital New Deal framework promotes the support of smart schools, which is described as online learning via smart devices and online textbooks, by substantially improving wireless network coverage across elementary, middle, and high schools, as well as by widely replacing old school computers with smart devices (MOEF 2020a, 57). Furthermore,

the framework suggests improving distance learning systems by expanding online learning platforms through adding content customization and learning management tools, and to bolster overall remote class infrastructure by upgrading management systems and video call capacities (MOEF 2020a, 57).

With the goal of expanding HR in the field of innovative growth, the Growth through Innovation initiative promotes the fostering of talent towards enabling convergence, as well as the expansion of software and semiconductor convergence education at universities (MOEF 2019, 41-2). In order to cultivate HR with technology convergence capacities, the initiative supports the expansion of master's and doctoral degrees focusing on innovative growth fields, and also promotes a stronger focus on addressing the FIR within those departments (MOEF 2019, 42). Aiming to increase the number of students receiving software education, support is to be delivered by specialized universities to spread basic software education, and software convergence colleges are to be established (MOEF 2019, 41). To foster semiconductor convergence specialists, the initiative advocates for the establishment of system semiconductor convergences courses based on a specialized graduate school program (MOEF 2019, 42). Aiming to develop talent with AI skills and AI convergence capabilities, the Growth through Innovation initiative promotes the expansion of AI graduate school courses, as well as to strengthen online AI education capacities (MOEF 2019, 40). Intending to exponentially increase the output of AI experts, the initiative proposes to foster high-level HR on master's and doctoral levels (MOEF 2019, 40). Specifically in cases where there is a shortage of professors with AI proficiencies, the initiative seeks to bolster AI education through providing tertiary education content in the form of online courses, expanding the foundation of AI education by providing undergraduate and master's level educational content (MOEF 2019, 40). In order to strengthen online education capabilities of universities, the Digital New Deal framework suggests improving online lectures by establishing distance learning support centers that ensure the usability of online learning management systems, as well as to produce training content for lecturers engaging in remote education (MOEF 2020a, 59). Additionally, the framework also advocates for replacing obsolete university network infrastructure and servers with new equipment, or, alternatively, for transitioning to a cloud-based server infrastructure (MOEF 2020a, 59).

Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing

In order to strengthen vocational training, the Growth through Innovation initiative promotes the implementation of training schemes developed by industry-leading companies

(MOEF 2019, 42). Aiming to enable firms to foster employee skills meeting the needs of businesses in the FIR, the initiative advocates for the creation of joint training centers under the leadership of experienced companies, making use of training programs that have proven to be successful in the real world, and centering on FIR occupations (MOEF 2019, 42). Through establishing a training scheme led by industry organizations and associations, the Growth through Innovation initiative intends to foster specific HR development, which reflects the needs of the respective industry sector, through vocational training schemes (MOEF 2019, 28). While the necessary framework for those training approaches, such as seminars or training centers, are to be provided directly, the initiative aims to boost these efforts by conducting them jointly with a large number of private companies active in similar fields, which I will elaborate on in a subsequent section (MOEF 2019, 28). Furthermore, with the goal of increasing flexibility within the labor market, the Growth through Innovation initiative also advocates for bolstering the development of highly skilled HR in the field of FIR technologies through apprenticeships and vocational college education (MOEF 2019, 45). Through promoting cooperation between industry and apprenticeship schools, as well as by expanding schemes that allow for working while learning in vocational colleges, the initiative seeks to improve HR competence in new technology fields such as robotics, IoT, or smart factories (MOEF 2019, 45).

Aiming to provide vocational training without temporal or spatial constraints, the Digital New Deal framework promotes, where possible, the transition to online vocational training systems (MOEF 2020a, 60). In order to support public providers of vocational training, the framework suggests implementing a comprehensive smart training and education platform, offering interactive and personalized learning services, along with virtual training functions in the form of augmented and virtual reality systems (MOEF 2020a, 60). While also promoting the possibility of sharing those public systems with private educational institutions, the framework advocates to further bolster private vocational training activities by supporting related institutions with the conversion of existing curricula to online programs as well as by providing on-site consulting and training of instructors (MOEF 2020a, 60-1). The Digital New Deal also promotes the provision of short-term training courses aiming to convey job-relevant FIR skills, which are to be designed in cooperation with higher educational institutions (MOEF 2020a, 61).

Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators

The PCFIR briefly mentions the implementation of schemes targeting the "revival of losers" in the sense of encouraging the re-challenge of entrepreneurship, specific strategic approaches are however not being put forward (PCFIR 2019, 75), and neither are they in any of the other frameworks provided by the Korean government.

Focusing broader humanitarian education / multi- & interdisciplinarity / lifelong learning / technical literacy

In order to strengthen the fostering of next generation HR for existing industries, which I have already touched upon earlier, the I-Korea 4.0 initiative, suggests adjusting technology education towards enabling future employees to fuse intelligent technologies with existing industrial models (MSIT 2017, 77). As far as university education goes, the I-Korea 4.0 initiative advocates for the provision of specialized curricula for convergence education, aiming to create an educational system capable of continuously producing talent with technology convergence capabilities (MSIT 2017, 78). As a further means to support the strengthening of convergence education, the I-Korea 4.0 initiative, too, promotes the spreading of STEAM education in elementary and secondary schools, aiming to expand the number of STEAM schools, to provide creative science spaces for students, and to connect scientific education with future career counseling (MSIT 2017, 78). Besides fostering AI and AI convergence HR through university education, as previously discussed, the Growth through Innovation initiative also promotes the provision of practical AI training through regional bases, utilizing curricula for non-majors (MOEF 2019, 40). Aiming to foster local talent, the initiative advocates for implementing AI training programs for employees and entrepreneurs within venture businesses and SMEs across all regions, enabling non-AI experts to utilize and converge AI technologies with their respective fields of expertise (MOEF 2019, 40). In this endeavor, the initiative intends to provide support in the form of online courses that provide educational content supporting practitioners in applying AI across all industries (MOEF 2019, 40). To further bolster learning processes in the AI field, the framework promotes building an open environment based on highly demanded and feasible data surrounding AI application and utilization (MOEF 2020a, 41). To support learning processes, the Digital New Deal framework promotes the provision of open data for training and learning activities, suggesting building an integrated online platform through which knowledge can be accessed and shared (MOEF 2020a, 41). For the development of HR in the blockchain field specifically, the PCFIR advocates to focus on cultivating talent that,

besides having the necessary technical skills, possesses a founded understanding of the blockchain industry (PCFIR 2019, 73). Therefore, the committee proposes to conduct blockchain education by fostering both coding skills as well as understanding of the business and the technology's potential use cases (PCFIR 2019, 73). The PCFIR identifies this as an important factor in raising international competitiveness of Korean businesses in this field, and even as a potential strategy to assume global leadership in the blockchain industry (PCFIR 2019, 73). Besides testing of manufacturing processes, the Digital New Deal also promotes the utilization of the smart industrial complex to conduct training of smart manufacturing specialists, suggesting conducting cooperative education programs between industry and academia, establishing education centers, and carrying out training courses specializing on smart manufacturing (MOEF 2020a, 75). With the goal of bolstering the adaptation of FIR port logistics infrastructure specifically, the Digital New Deal advocates for the establishment of training schemes directed at skill development around the field of smart port logistics operations, targeting both existing and prospective employees (MOEF 2020a, 77).

To support lifelong education, the Growth through Innovation initiative promotes the establishment of lifelong learning bases open to citizens throughout regions (MOEF 2019, 42). This strategy is to be further supported through a university-lead lifelong learning activation project, which is backed by the Ministry of Education (MOEF 2019, 42). Aiming to increase labor market flexibility, the Growth through Innovation initiative suggests strengthening systems that incentivize learning while working (MOEF 2019, 45). In the light of steady diversification of employment types, the initiative seeks to support both employed and unemployed workers by introducing a so-called "Lifelong Learning Card", which is to be introduced in order to make continuous learning opportunities more accessible and affordable (MOEF 2019, 45). As another integral part of their educational agenda, the PCFIR, too, promotes the introduction of a lifelong learning system that can actively respond to changes in the working environment caused by the FIR (PCFIR 2019, 57). To react to changing demands in future HR requirements, the committee advocates for innovating lifelong learning schemes through applying advanced learning and teaching methods that support the creation of skills in the FIR era (PCFIR 2019, 57). It is being suggested to redesign lifelong learning schemes to be focused on improving creative problem-solving skills required in future workplaces, rather than simply centering on traditional job training (PCFIR 2019, 57). The overall aim, as pointed out by the PCFIR, should be to secure social protection and educational support to those HR that are underprivileged and at risk of being alienated by the effects of technological development (PCFIR 2019, 57). The

I-Korea 4.0 initiative states that the previously mentioned intelligent teaching and learning platform could also be utilized to support lifelong learning activities, and to aid the development of competencies and re-education efforts throughout working life (MSIT 2017, 79). As another means to provide job safety, the I-Korea 4.0 response plan suggests improving educational measures that support career change, particularly in response to changing job requirements and workplace automation (MSIT 2017, 80). Catering to both unemployed and currently employed individuals, the response plan promotes the provision of training and education in accordance with industry demand, such as educational courses on technology relevant to the FIR, smart factory training, or the establishment of polytechnic schools specializing in ongoing education (MSIT 2017, 81). To support remote lifelong learning activities, the Digital New Deal promotes publicly offering access to higher education via massive open online courses (MOEF 2020a, 60). The number of currently available courses is to be substantially increased, aiming to further cover topics related to the FIR, and international coursework is also to be provided (MOEF 2020a, 60).

Preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation

With the goal of adjusting institutional foundations to better reflect changes in the work environment, as well as to secure a continuous cycle of work and learning, the PCFIR suggests a number of changes concerning rules and norms in the labor sector (PCFIR 2019, 54-5). The committee promotes the strengthening of basic worker rights surrounding safety and health, as well as the provision of sufficient opportunities allowing individuals to work autonomously (PCFIR 2019, 54). Norms in the labor sector are suggested to be improved towards better securing worker independence and autonomy, as well as towards being more flexible to changes of jobs due to technological developments (PCFIR 2019, 54). In order to enable all actors to better react to changes in the labor environment caused by the FIR, the PCFIR suggests institutionalizing and updating functions of private and public entities based on a multi-layered decision-making structure, allowing social partners to make cooperation-based decisions, and enabling firms to autonomously respond to changes in the HR sector (PCFIR 2019, 55). In this context, the committee also states the importance of setting up a social security system supporting professions that are at risk due to technological advancements (PCFIR 2019, 55).

As part of a strategy to innovate administrative services, on which I will elaborate on in a subsequent section, the Growth through Innovation initiative promotes the establishment of a national job information platform, providing individualized information on topics such as recruitment, employment policies, and vocational training (MOEF 2019, 33). This service, which is to be provided by the Ministry of Employment and Labor and its subsidiaries, is designed to allow individuals to access job-related information in one place (MOEF 2019, 33). Through utilizing big data technologies, the I-Korea 4.0 initiative promotes providing support to job seekers on a personalized level through interlinking individual data, such as education and employment history, with private and public career portals (MSIT 2017, 80). Also, the expansion of public employment systems is suggested to be facilitated by providing online consultation chatbots, AI-backed recruiting and job matching mechanisms, company information systems, as well as by personalizing employment services through person-to-person counseling and the establishment of customized individual consultation (MOEF 2019, 45).

Besides bolstering public employment services, aiming to further increase flexibility in the labor market, the Growth through Innovation initiative promotes the expansion of flexible wage systems and working hours (MOEF 2019, 45). Aiming to enhance labor market dynamics by adjusting working hours to be more flexible, the initiative promotes the improvement of labor standards to allow for more efficient use of working time by expanding the number of hours that can be used flexibly (MOEF 2019, 45). To enhance the flexibility of current wage systems, the initiative promotes the step-by-step introduction of an official wage system within which the value of the respective job, rather than mere seniority, is being reflected, aiming to incentivize transitions through providing labor-management consultation (MOEF 2019, 45).

As another means to bolster a researcher-centered innovation environment, the I-Korea initiative promotes reinforcing researcher compensation schemes to be more fair, proposing to simplify administrative procedures and to expand follow-up research, as well as to allow for early completion declaration and the provision of incentives (MSIT 2017, 66-7). Also aiming to improve recruitment and industry matching processes of research personnel, the Growth through Innovation initiative promotes cooperation between industry and academia through establishing contract departments, connecting university research groups with businesses, and facilitating regional cooperative training programs (MOEF 2019, 41), all of which I will elaborate on in a subsequent section.

Aiming to bolster innovation capacities within the HR sector by improving employment stability, the Growth through Innovation initiative promotes the reinforcement of social

insurance and unemployment benefits, the expansion of the employment safety net, as well as the overall improvement of worker treatment (MOEF 2019, 46). Coverage of social insurance and benefits for the unemployed is advocated to be strengthened by increasing payment periods and amounts of unemployment benefits, by expanding maximum amounts of earned income tax credits for low-income households, and by assisting working poor who are not covered by employment insurance (MOEF 2019, 46). HR treatment is promoted to be boosted by improving working conditions of public employees, such as government workers or employees of public educational institutions, through conversion from non-regular to regular employment, and, on a rather general note, by improving working conditions and wages of SMEs (MOEF 2019, 46). The employment safety net, finally, is to be enhanced by bolstering industrial accident insurance for certain occupations and high-risk fields, as well as by designing policies that protect employee health based on statistical risks surrounding aspects such as working conditions, working hours, and age (MOEF 2019, 46). In order to make sure that all members of society benefit from the technological development brought on by the FIR, and to secure social stability, the PCFIR promotes innovating the social security system and to widely diversify social security resources (PCFIR 2019, 57-8). The committee suggests moving away from a social security system based on labor relations and standard employment, and advocates for transitioning to a system guaranteeing social security universally to all citizens, regardless of employment type or lifestyle (PCFIR 2019, 58). Aim of this transition is to create a safety net without blind spots, which encourages individuals to proactively take part in the innovation process (PCFIR 2019, 58). As a means to strengthen the employment safety net, the I-Korea response plan, too, suggests covering insurance blind spots by expanding employment insurance to all types of workers regardless of employment status, to enhance unemployment coverage duration, as well as to increase the level of wages in the case of re-employment (MSIT 2017, 81). In the light of changes in the labor sector caused by the FIR, the initiative further proposes to prepare for necessary changes of the labor law to better reflect new work environments, mentioning the protection of platform workers as an example area in need of regulation (MSIT 2017, 81). Briefly touching upon the topic of a basic income, the committee also states the necessity of introducing a wage system that secures minimum wages for people of all employment types (PCFIR 2019, 58). As far as the diversification of social security resources goes, the PCFIR suggests establishing a solid social security fund through expanding the tax base, rationalizing taxation schemes, and managing finances more efficiently (PCFIR 2019, 58). Furthermore, to make sure that social inequalities are being alleviated and acceptance of the FIR can be enhanced, the committee states that economic results of technological

advancement need to be shared equally through institutionalizing the social distribution system (PCFIR 2019, 58). The possibility of introducing a system in which beneficiaries of technological advancement are required to take on financial responsibility for alleviating inequality is also being considered (PCFIR 2019, 58). The committee furthermore advocates for investigating the influence that current finance regimes have on welfare through using finance data, and to assess how financial data can be used to improve the social safety net (PCFIR 2019, 63). In light of the forecasted decrease of jobs in the mobility and logistics sectors specifically, the PCFIR promotes creating a win-win situation through focusing on the increase in personnel demand caused by the expected growth of those same industries (PCFIR 2019, 65). The committee suggests addressing policy design to be conducted under consideration of those two contrasting factors, and advocates for countermeasures to be taken preemptively (PCFIR 2019, 65).

In order to enable SMEs to extend their innovative HR assets, the Growth through Innovation initiative sets out to support them in expanding and advancing their human capital, aiming to allow for SMEs to secure excellent R&D personnel (MOEF 2019, 28). To that end, the initiative promotes subsidizing salaries of a certain number of employees within target businesses, as well as increasing direct assignments of science and engineering personnel serving in the military to SMEs (MOEF 2019, 28). As an approach towards encouraging entrepreneurship, the PCFIR suggests adjusting work and employment laws in the startup sector towards allowing for more flexibility (PCFIR 2019, 75). Aiming to expand management discretion, startup businesses are to be provided with the liberty of flexibly deciding on work methods and hours, as well as on employment types (PCFIR 2019, 75).

Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility

In order to attract foreign HR, particularly in fields with weak national research capabilities, the I-Korea initiative suggests to actively invite talent in the intelligent technology field, to reinforce global networks, and to overall strengthen the competitiveness of industry and academia R&D efforts (MSIT 2017, 77). However, no details on how to approach these rather vague objectives are being provided.

Strengthening support for external competence building, enable HR development through university-industry relations

Aiming to foster HR with applied knowledge of the new industries, the I-Korea response plan promotes nurturing talent through industry-academia cooperation (MSIT 2017, 77-8). To achieve this, the response plan suggests cultivating HR by conducting on-site training and project-based learning activities, as well as to allow for the participation of education and training within specialized institutions, such as cooperative industry-academia information security graduate schools (MSIT 2017, 77-8). With the goal of fostering new jobs to better meet the needs of the FIR, as well as to combat potential job decline due to increasing automation, the PCFIR promotes bolstering the continuous creation of new jobs through industry-academia cooperation (PCFIR 2019, 54). HR development is being recommended to be backed by encouraging active collaboration between academia and industry sector organizations, focusing on both developing HR in new jobs that are likely to rise in demand due to technological changes, as well as maintaining existing jobs by engaging in workplace innovation (PCFIR 2019, 54). While pointing out the importance of supporting established firms in existing industries, the PCFIR particularly mentions the necessity of supporting technology startups in participating in the job creation process (PCFIR 2019, 54).

As a means of bolstering the development of HR in the innovative growth field through providing external HR development support, the Growth through Innovation initiative promotes the establishment of contract departments within universities, the improvement of industry-academia matching, and the creation of regional technology cooperation programs (MOEF 2019, 41). Through designating contract departments, which are defined as courses that are being operated in contract with public or private agencies, to additional leading universities, the initiative aims to allow for training to be tailored towards industry innovation needs, to enable universities to provide additional education outside their quotas, and to secure future employment of graduates (MOEF 2019, 41). To further improve matching between industry and new research talent, the initiative advocates for connecting university core research groups with SMEs active in the innovative growth field, and for providing them with additional R&D support (MOEF 2019, 41).

To make sure that innovative growth HR can also be nurtured on a regional level, the initiative supports the linking of local industries with smart technologies, such as AI and IoT, which can be utilized to conduct cooperative training programs for employees among local companies (MOEF 2019, 41). As already touched upon earlier, in order to facilitate industry specific HR

development through vocational training, the Growth through Innovation initiative promotes conducting vocational training jointly among a large number of companies engaging in similar activities (MOEF 2019, 28). In addition to theoretical education aspects, such training courses are to be conducted at individual workspaces that possess the relevant industry's features, and educational visits to institutions that hold advanced training capabilities are to be facilitated (MOEF 2019, 28). The overall aim is to employ a win-win education system for SMEs, and to strengthen regional and industry-specific enterprises, while also securing SME coexistence (MOEF 2019, 28). As an approach to the development of HR in charge of smart manufacturing innovation, besides educating new talent, the PCFIR also promotes company-led education schemes for incumbent workers engaged in smart factory operations through collaboration with outside companies, as well as through training provided by external specialized educational institutions (PCFIR 2019, 62). To improve education and training efforts within SMEs specifically, the committee suggests encouraging participation through provision of incentives to involved employees and companies (PCFIR 2019, 62). In order to ensure the emergence of AI companies, the PCFIR also promotes the development of AI talent through linking education with training on industrial sites (PCFIR 2019, 69). As a means of narrowing the gap between education and industry, the committee suggests analogous training and R&D activities and the provision of internships, as well as to assess the development of HR in the AI field by introducing a workforce index (PCFIR 2019, 69).

4.6 Financial Incentives to Enterprises

4.6.1 Japan

Direct stimulants in the form of economic subsidies & investment, improving capital fluidity

As already touched upon previously, the basic plan sets out to foster innovation within the startup sector through the provision of funding and outlines the intent to provide large-scale direct financial support of research in the form of gap funds (CAO 2021, 33). To promote corporate innovation activities, the basic plan suggests implementing a guideline system that evaluates the efforts taken by firms towards managing and facilitating innovation, reviewing aspects such as the overall organization, corporate processes, or corporate culture (CAO 2021, 33). Those evaluations will then be the basis of considerations regarding the public funding of private innovation activities (CAO 2021, 33). The assessments are to put emphasis on the

capacity of innovation activities to solve social issues, as well as on their efforts towards developing open-source technologies (CAO 2021, 33-4). Furthermore, in order to spur the development of AI technologies specifically, the Connected Industries initiative advocates for financial support of initiatives enabling the collaboration between established enterprises and new ventures, details of which I will discuss in a subsequent section, trough directly funding R&D efforts and AI system implementations of such projects (METI 2017, 31).

Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding

As far as public support surrounding areas such as credit loans, equity funding, advances, or risk-sharing goes, no support strategies have been proposed by the Japanese policy frameworks.

Indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings

In addition to the direct funding measures for small businesses mentioned above, the basic plan also suggests supporting the formation of venture capital funds as an objective in order to foster innovation within the startup sector (CAO 2021, 33). Aiming to increase the amount of inward foreign direct investment (FDI), the Abenomics framework puts forward the plan to host FDI seminars to provide Japanese businesses with information on opportunities to receive FDI (JapanGov 2020, 15).

Tax benefits & relief aimed at supporting R&D activities such as tax reductions / tax exemptions / tax incentives / tax credits

To further improve the productivity of SMEs specifically, the Abenomics framework also suggests reducing property tax for SMEs making capital investments in technologies such as ICT, cloud, or robotics (JapanGov 2020, 14). The Abenomics program also attempts to reduce corporate tax by reforming the tax scheme to be more growth-oriented (JapanGov 2020, 15). With the aim of reducing the overall corporate tax rate below the 30% mark, the framework intends to reduce the taxes on corporate profits to 25% for companies that proactively undertake capital investments and increase wages (JapanGov 2020, 15). Additionally, for firms that proactively invest in IT, the program sets out to further lower corporate profit taxes to 20% (JapanGov 2020, 15).

4.6.2 Korea

Direct stimulants in the form of economic subsidies & investment, improving capital fluidity

Financing measures promoted by the Growth through Innovation initiative include direct government investments in R&D activities, as well as setting up exclusive growth funds for selected crucial industries (MOEF 2019, 15). The initiative points out the importance of cooperation of various public institutions and ministries in designing financing policies and distributing public funds (MOEF 2019, 15-6). The PCFIR states the need to implement policy financing strategies for areas requiring large scale investments, such as smart cities or 5G networks, since governance investment alone might be limited, and private financing might be insufficient due to the high degree of investment uncertainty (PCFIR 2019, 63). It is therefore being suggested to actively provide financial support through supplying long-term financing, with the aim of aiding specific policy purposes (PCFIR 2019, 63). To encourage the use of AI technologies in the private sector, the Growth through Innovation initiative, as part of the 3+1 strategic investment fields strategy, promotes the provision of vouchers to allow firms to better explore them and to facilitate their introduction (MOEF 2019, 11). As a means of supporting the development of smart manufacturing methods specifically, the Digital New Deal framework proposes to supply 5 trillion won in funding to several selected companies, aiming to bolster the private sector transition to smart factory and manufacturing robotics environments (MOEF 2020a, 43). In order to further support the development of smart logistics facilities by the private sector, the Digital New Deal framework suggests providing financial support for building advanced logistics facilities, as well as for investing in them (MOEF 2020a, 77).

As a means of backing innovative startups and venture companies through direct funding, the Growth through Innovation initiative promotes the creation of a scale-up fund specifically targeting the support of new growth sectors (MOEF 2019, 28-9). With the government acting as a liquidity provider through subsidies and policy funds, the PCFIR promotes the establishment of a virtuous investment cycle for startups, attracting private investment after initial public funding (PCFIR 2019, 75). To further facilitate early government funding to startups, the committee also advocates for simplifying administrative procedures and to make the scope of available funds more flexible, allowing for more business experimentation and exploration (PCFIR 2019, 75). Also aiming to support the growth of the SME and startup sector by providing direct funding, the I-Korea 4.0 response plan proposes to drastically increase the percentage of R&D support funds going to ventures engaging in FIR technology development (MSIT 2017,

75). Furthermore, the response plan also suggests creating an innovation adventure fund over 10 trillion won, as well as to expand the so-called “Growth Ladder Fund”, which aims to give individualized support to businesses depending on their stage of growth (MSIT 2017, 75). To cultivate digital transformation of the industry sector, the Digital New Deal framework proposes to establish funding over 6 trillion won for venture business in the contact-free, bio, and green fields, supporting technologies such as AI, 5G, and big data (MOEF 2020a, 45).

Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding

With the goal of fostering digital innovation in the manufacturing sector, the I-Korea 4.0 initiative promotes the provision of loans to businesses aiming to transition from conventional manufacturing to smart manufacturing systems (MSIT 2017, 39-40). To specifically strengthen startup enterprises in business recovery and re-challenging processes, the initiative promotes the introduction of a credit model that integrates both credit evaluation and technology evaluation in one place (MSIT 2017, 75). Furthermore, the initiative suggests abolishing the joint guarantee system as a means of getting access to loans and funding for startups (MSIT 2017, 75). To further widen the scope of financial support for investment in innovation, the Growth through Innovation framework advocates for converting the corporate credit system to one that evaluates levels of creditworthiness based on future growth potential rather than past performance (MOEF 2019, 29). To achieve this, the initiative sets out to establish a unified credit review model which takes into account the target company's technology development process along with other qualitative growth factors, such as sales performance, while also considering tangible and intangible assets (MOEF 2019, 29). In addition, the initiative encourages banks to provide intellectual property mortgage loans to innovative enterprises, incentivizing financial institutions to do so by publicly providing valuation support, as well as through publicly providing recovery aid in case of default on the mortgage (MOEF 2019, 29-30).

Indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings

Aiming to widen the possibilities of supporting start-up formation, the Growth through Innovation initiative promotes investment schemes based on intellectual property held by the target business (MOEF 2019, 29). Contrary to larger-scale venture investment strategies, individual investments in intellectual property can be made on a smaller scale, allowing for easier

access to funds for startups (MOEF 2019, 29). Identifying corporate finance as an important growth factor for innovation towards the FIR, especially for new ventures and startups, the PCFIR sets out to bolster corporate financing processes through providing a support system for technology investment (PCFIR 2019, 63). Besides allowing for the initial assessment of a company's technological capabilities and the evaluation of future growth potential, a support system for areas such as fostering suitable venture capital sources, investment finance, and acquisition finance for supporting innovative growth is to be established (PCFIR 2019, 63). The PCFIR also promotes improving the domestic venture ecosystem by creating policy financing strategies that support private technology investment (PCFIR 2019, 63). To enable large companies to invest in startup businesses more actively, the committee furthermore promotes the revision of related regulations towards facilitating venture investment processes (PCFIR 2019, 75). In a more general approach towards incentivizing investment in innovative businesses, the Growth through Innovation initiative seeks to activate an indemnity system, within which immunity to damages is to be provided to investors supporting innovative companies (MOEF 2019, 30). To that end, the initiative intends to establish an institutional basis to reviewing investment processes, examining immunity, and specifying reasons for indemnification for mortgages and loans to innovative businesses (MOEF 2019, 30). As another means to support business recovery in the startup sector, the I-Korea 4.0 response plan advocates for expanding re-challenging support through promoting fundraising, suggesting encouraging crowdfunding activities by easing funding restrictions and by substantially raising the maximum investment limits per year and company (MSIT 2017, 75).

With the goal of creating win-win situations through open innovation in the private sector, the Growth through Innovation initiative intends to expand the scope of strategic venture funds provided by large companies (MOEF 2019, 25). In order to allow large enterprises and financial firms to do so, support strategies such as parent investment, parent funds, or follow-up management support are being promoted by the initiative (MOEF 2019, 25). Such strategies are designed to support venture companies by boosting their funding, while, through cooperation and mergers with venture businesses, investing companies may gain access to new innovative capabilities (MOEF 2019, 25).

The I-Korea 4.0 initiative suggests expanding application standards to be listed on the "Korea New Exchange", a domestic securities exchange for SMEs exclusively, by lifting obligations to submit securities reports, as well as to increase the total amount of public offering within the exchange (MSIT 2017, 76). Regarding new public listings, the PCFIR advocates for

higher flexibility through deciding on whether or not to allow listings based on enterprises' core competencies rather than just continuity or sales results (PCFIR 2019, 75).

Tax benefits & relief aimed at supporting R&D activities such as tax reductions / tax exemptions / tax incentives / tax credits

As an approach towards fostering development in the high-tech sector, the Growth through Innovation strategy specifically promotes tax support to enterprises active in foundry model cooperation (MOEF 2019, 16). Through offering tax credits and higher tax deduction rates for companies actively engaging in R&D through the foundry approach, the initiative seeks to spur growth in the semiconductor sector and its various niche subsectors (MOEF 2019, 16). As a means of enabling open innovation, the Growth through Innovation initiative also promotes the introduction of R&D tax credits to overseas businesses that are controlled either directly or indirectly by Korean corporations, aiming to support the utilization of R&D resources in international growth fields, while making sure to prevent technology leakage (MOEF 2019, 25). Moreover, aiming to bolster the development of new growth engines, the Growth through Innovation initiative promotes the strengthening of incentives for R&D through expanding the provision of tax credits for efforts aiming at the development of core technologies, such as AI, 5G, autonomous driving, intelligent semiconductors, or green technologies (MOEF 2019, 27).

4.7 Competition, Intellectual Property, and Standards

4.7.1 Japan

Antitrust policies targeting cartelization / vertical restrictions / merger regulation, interconnecting new enterprises with persistent monopoly

In order to promote open innovation in an environment in which large corporations collaborate with startups, the basic plan sets out to create conditions under which all stakeholders can both conduct joint research as well as compete in a free and fair manner (CAO 2021, 33). The means outlined to create such an environment are the adjustment of regulations concerning inter-firm contracts, as well as the development of guidelines preventing the continuation and formation of monopolies (CAO 2021, 33). Furthermore, to improve the level of competitiveness among SMEs, the Abenomics framework sets out to provide them with support in topics related to ownership and business transition (JapanGov 2020, 14). Aiming to increase the competitiveness of Japanese businesses by supporting frontier technological development, specifically around the development of AI systems, the Connected Industries initiative sets out to

enable and fund the establishment of core technologies by facilitating collaboration between established companies and venture businesses (METI 2017, 31). Instituting a cooperative system in which large and medium-sized companies contribute insights on the utilization of AI technologies and large amounts of data, while venture businesses and innovative individuals provide prototypes and new ideas, is promoted as a means of accelerating the innovation cycle of such technologies (METI 2017, 31).

Regulating intellectual property through patent law / regulating knowledge transaction / knowledge rights / regulating knowledge co-creation / taxation schemes incentivizing intellectual property assets

In order to ensure the application of best practices within Japan's digital market, the Abenomics framework sets out to define rules directed at data security and the handling of data (JapanGov 2020, 11). This strategy aims at designing new policies and reviewing existing policies concerning competition in the digital market, as well as the transfer and interaction of data between different platforms and IT environments (JapanGov 2020, 11). The strategy is based on the concept of "Data Free Flow with Trust" (DFFT), which aims "to ensure privacy, data protection, intellectual property rights, and security in order to facilitate the free flow of data, which will harness the full potential of data and the digital economy" (JapanGov 2020, 11). Aiming to increase industrial competitiveness, the basic plan tasks the Information-technology Promotion Agency (IPA) to ensure the safe distribution and sharing of data between actors within the private sector (CAO 2021, 19-20). With the intent to develop a reliable environment for data distribution and to improve data governance, the basic plan suggests investigating the current state of institutions that promote data exchange, such as data trading markets or information banks, until the end of 2021 (CAO 2021, 20). Regulations regarding the handling of privately owned data are also to be instituted within 2021, in order to promote their utilization and to ensure data security as well as data reliability to all stakeholders (CAO 2021, 20). In addition, the necessary processes to guarantee trustworthiness and data authenticity are also to be established in the coming years (CAO 2021, 20).

To ensure that efforts towards data cooperation between companies can be conducted safely, the Connected Industries initiative advocates for implementing cyber security measures targeting data sharing processes, and it sets out to investigate and audit their security regimes (METI 2017, 30). To further encourage data cooperation within the industry sector, the initiative promotes the establishment of a tax break scheme targeting data sharing activities among private companies (METI 2017, 30). In addition, the initiative has further set out to revise guidelines

aiming to encourage firms to utilize contracts in order to secure the utilization of industrial data, by specifying the relationships of AI rights and responsibilities (METI 2017, 34). The new guidelines provide, besides general advice on how to put data utilization contracts in place, information on how to contractualize shared AI development processes, including concrete methodologies and example clauses across all stages (METI 2017, 34).

Imposing technical standards, altering health / safety / environmental regulations

With the intent of implementing structural reforms in accordance with Society 5.0 on a national level, the Abenomics program has chosen to assign a total of 10 regions across the country the status of "national strategic special zones" (JapanGov 2020, 10). Those regions have been exempted to undergo pioneering structural reforms ahead of the rest of the country, totaling to 335 reforms as of September 2019, with the aim of enabling lawmakers to evaluate which reforms can be implemented nationwide (JapanGov 2020, 10). Moreover, through the provision of regulatory sandboxes, which I have already touched upon earlier, the Abenomics program also sets out to make way for regulatory reforms necessary in order to roll out new technologies or business models, after they have been tested in a sandbox environment (JapanGov 2020, 10).

Identifying decarbonizing society as an integral aspect in realizing Society 5.0, the Abenomics program sets out to initiate and support measures reducing greenhouse gas emissions by 80% until 2050 (JapanGov 2020, 11). In accordance with the Paris Agreement, a long-term strategy has been decided upon by the cabinet in June 2019, which aims to improve environmental protection, while at the same time stimulating economic growth by promoting innovation of green technologies (JapanGov 2020, 11). Among the approaches mentioned by the framework to bolster decarbonization are the promotion of zero carbon mobility by utilizing non-gasoline engines, alongside the promotion of a hydrogen society by improving hydrogen distribution network and reducing hydrogen production costs (JapanGov 2020, 11). Furthermore, through utilizing AI and IoT technologies, resource distribution is planned to become more efficient, and the strategy also sets out to stimulate green finance by emphasizing environmental factors in the investment process (JapanGov 2020, 11). Aiming to adjust standards and regulations regarding global change, the basic plan announces to implement the "Green Food System Strategy", a scheme to implement new policies targeting productivity and sustainability of the agriculture, fishery, and forestry sectors, aiming to achieve carbon neutrality by 2050, as well as to enable the proactive involvement in transnational regulatory processes (CAO 2021, 24).

As already mentioned, as a part of the rules for Japan's digital market and the DFFT concept, the Abenomics framework also sets out to guarantee data protection, privacy, and overall data security standards (JapanGov 2020, 11). The program furthermore specifically mentions its intent to assure fairness and transparency in data transactions between digital platforms provided by corporations and their users (JapanGov 2020, 11). As part of the previously mentioned strategy to protect privately owned data, the basic plan, too, states the intent to improve measures directed at protecting personal data (CAO 2021, 20).

Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms

Aiming at securing sustainable growth, the Abenomics framework puts forward a plan to strengthen governance of group companies and to enhance their overall value by publishing a set of governance guidelines in the form of a corporate governance code (JapanGov 2020, 15). The code sets out to promote decision-making among the listed firms in a fair, transparent, timely, and decisive manner (JapanGov 2020, 15). The framework also plans to adjust the code by adding the requirement for listed firms to further enhance their governance efforts by appointing independent directors from outside their own corporate structures (JapanGov 2020, 15). In addition to the corporate governance code, a stewardship code has been composed and revised in 2017 (JapanGov 2020, 15). Goal of the stewardship code is to promote a mutually profitable dialogue between investee firms and institutional investors, and it has thus far been accepted by over 270 institutional investment agents (JapanGov 2020, 15).

Improving international competitiveness through adjusting tariff & non-tariff barriers / export restrictions / trade agreements / currency regulations, prevention of international exploitation

Through utilizing an international collaboration working group headed by stakeholders from both academia and industry, which has been established in cooperation between the METI and the Ministry of Internal Affairs and Communications, the Connected Industries initiative aims to improve and accelerate the environment for industrial collaboration on an international level (METI 2017, 32). The working group was formed to both support partner countries, as well as to introduce Japanese firms to overseas businesses eligible for collaboration within those partner countries (METI 2017, 32). Support by the government is to be issued in the form of financial aid, provision of subsidies, and support of HR development (METI 2017, 32). In order to foster partnerships with foreign businesses, the Abenomics framework sets out to streamline administrative processes for transnational firms (JapanGov 2020, 15). The program specifically

mentions the reduction of administrative costs for businesses in areas that are considered particularly heavy burdens, such as business licenses or social insurance (JapanGov 2020, 15). To facilitate the registration process, it further suggests yielding the opportunity of handling various documents through one single outlet, such as provided in the form of the "Tokyo One-Stop Business Establishment Center" (JapanGov 2020, 15). By providing them with the necessary information, the Abenomics framework sets out to encourage SMEs to expand overseas (JapanGov 2020, 14). It also lays out a plan to increase infrastructure financing across the globe, and to improve the quality of such investments by taking advantage of Japanese know-how and technology (JapanGov 2020, 12). To that end, it suggests nourishing projects around economic cooperation with other countries, to promote active participation in project operation, and, as I have already mentioned earlier, to improve international collaboration by enabling public-private cooperation (JapanGov 2020, 12). In addition, the program aims to make Japan's startup ecosystem more attractive on a global stage by introducing them at leading international industry conferences (JapanGov 2020, 14), and by supporting the matching of Japanese SMEs with international companies via the "J-GoodTech" website (JapanGov 2020, 15).

Similar to the measures already discussed above, in order to contribute to the shift towards a digital society on an international scale, the basic plan promotes a global data distribution framework based on mutual standards and rules regarding data security, quality and privacy (CAO 2021, 21). To support the implementation of such a framework, the basic plan suggests engaging in international dialogue on the ideal state of a digital society, and to present examples of good data practice at international gatherings such as the OECD or G7 (CAO 2021, 21). In order to further promote the transition to an international digital society, the Society 5.0 concept is also stated to take a central part in the 2025 Osaka Expo (CAO 2021, 21). The "Osaka Track", which was launched during the 2019 G20 Osaka summit, is also based on the concept of DFFT (JapanGov 2020, 11). It is being pointed out that this initiative was successful in bolstering the international rule-making progress in regard to the digital economy, as well as in driving forward negotiations concerning e-commerce at the World Trade Organization (JapanGov 2020, 11).

While encouraging the international exchange of knowledge, in the light of the ever-growing factor of technology outflow, the basic plan states the intent to set up institutional frameworks addressing the issue of technology leaks (CAO 2021, 30). Aiming to support intellectual property and standardization efforts on an international level, the basic plan states that control measures in this regard are to be strengthened and accelerated (CAO 2021, 43-4). The basic

plan aims to do so by formulating regulations and systems that create an overall environment in which change in corporate behavior regarding the application standards is being encouraged (CAO 2021, 44). Furthermore, additional project areas identified to fortify the utilization of international standards evolve around awareness raising, strengthening HR, and direct support of private business activities by government-affiliated organizations (CAO 2021, 44). Moreover, in order to bolster Japan's traction within the global marketplace, especially in quickly advancing markets such as the ICT technology field, the Connected Industries initiative calls for the improvement of Japan's international standardization strategy (METI 2017, 33). Besides generally uniting international standardization efforts by the public and private sectors, the initiative also promotes the improvement of HR engaging in future international standard setting, through activities such as taking on leading roles in international technology consortiums, as a specific measure to enhance Japan's global standing in this regard (METI 2017, 33). Measures identified to foster international leadership HR are specific training systems, university courses, training in collaboration with transnational organizations, and strengthening networking across generations (METI 2017, 33).

With the aim of improving the standing of Japanese businesses on an international stage, the Abenomics framework promotes trade agreements as a means of driving forward Society 5.0 (JapanGov 2020, 12). The program specifically mentions the Comprehensive and Progressive Agreement for Trans-Pacific Partnership, the Japan-EU Economic Partnership Agreement, and the Japan-U.S. Trade Agreement as measures that enable innovation on a cross-national level, all of which entered in force over the last few years (JapanGov 2020, 12).

Another angle chosen by the Abenomics framework to improve international opportunities is through supporting tourism to Japan, Japanese cuisine and agriculture, as well as regional revitalization (JapanGov 2020, 13). To bolster tourism, the program sets out to found destination management organizations to manage local tourism development and to train hospitality management personnel, as well as to promote branding activities targeting cultural sights and national parks (JapanGov 2020, 13). Also, it stipulates that international tourism to Japan can be encouraged by improving the overall quality of visitor experience through measures such as improving public Wi-Fi connectivity, improving cashless payment infrastructure, or promoting certified private lodging services (JapanGov 2020, 13). As far as food and agriculture go, the framework identifies an opportunity to further increase the global marketability of Japanese cuisine: in light of the increasing consumer demand for healthy food, Japan having the highest life expectancy globally, while also ranking as the lowest OECD country in terms of obesity

ratio, is being identified as a means to further support the export of Japanese food (JapanGov 2020, 13). The Abenomics program aims to spur export potential and plans to promote exports by utilizing the Japan Food Product Overseas Promotion Center (JapanGov 2020, 13). The program plans to back agricultural business with improving the scale of consolidation and accumulation of farmland by providing support in the form of dedicated banking opportunities, and further intends to utilize similar approaches within the fishing and forestry industries (JapanGov 2020, 13).

4.7.2 Korea

Antitrust policies targeting cartelization / vertical restrictions / merger regulation, interconnecting new enterprises with persistent monopoly

The I-Korea 4.0 response plan advocates for strengthening monitoring of monopoly abuse by established technology companies, promoting the increase of financial repercussions for violations against competition regulations (MSIT 2017, 71). In order to establish fair competition among the new industries, the response plan suggests evaluating the current regulatory framework, aiming to discover restrictive regulations that prevent market entry or innovative activities of new businesses (MSIT 2017, 71). As far as the transformation of competition laws goes, the Growth through Innovation initiative sets out to overhaul competition legislation surrounding the use of big data, specifically promoting to continuously maintain regulation combating anti-competitive practices such as algorithmic collusion and automated price matching (MOEF 2019, 44). In addition, to further facilitate mergers and acquisitions between SMEs and large conglomerates, the response plan also advocates for the extension of maintaining SME status for venture businesses from three to seven years post merger (MSIT 2017, 76).

As another aspect of backing the prior mentioned innovation cooperation in the manufacturing field, the PCFIR particularly promotes the support of R&D projects between large companies and SMEs (PCFIR 2019, 61). Through fostering collaboration by strategies such as the cooperative value chain approach, the committee sees an opportunity to redefine the relationship between the two (PCFIR 2019, 61). This plan is being identified as a pragmatic development plan, as it reflects the merits and characteristics of the country's industrial setting (PCFIR 2019, 61-2). The committee also identifies the previously mentioned data and resource sharing platform as a measure to resolve resource and information imbalances between large companies and SMEs, therewith enabling the alleviation of social issues caused by such imbalances, as well as aiding in overcoming the limitations of segmented industrial policies (PCFIR 2019,

62). Through facilitating collaborations between large companies and SMEs, the Growth through Innovation initiative, too, seeks to accelerate innovation processes in the manufacturing field, as well as to establish win-win relationships among the involved enterprises (MOEF 2019, 19). The initiative specifically promotes the smart factory approach as an area in which such collaborations are to be established, advocating for government sponsorship of such projects, along with the provision of consultancy and one-stop support for smart factory development (MOEF 2019, 19).

Regulating intellectual property through patent law / regulating knowledge transaction / knowledge rights / regulating knowledge co-creation / taxation schemes incentivizing intellectual property assets

To further support the development towards an innovation-friendly environment, the I-Korea 4.0 initiative promotes the modernization of the patent system to better secure intellectual property rights of new technologies (MSIT 2017, 72). To facilitate this, the initiative suggests overhauling the patent examination criteria currently in place, as well as to change patent examination systems to prioritize technologies relevant to the FIR to be processed more urgently (MSIT 2017, 72). As a means of preventing the infringement of intellectual property in the form of theft or imitation, the initiative promotes improving investigatory measures targeting data leakage, as well as introducing punitive compensation for violations of patents or intellectual property rights (MSIT 2017, 72). The initiative particularly mentions software distributed online as an area in which patent protection systems are in need of improvement, and also points out the necessity of considering the regulation ownership rights to intellectual property created by AI (MSIT 2017, 71-2).

In order to enable technology convergence between businesses, and to smooth the connection between service and manufacturing industries, the Growth through Innovation initiative sets out to revise and improve regulations governing the coupling between firms, as well as to readjust the boundaries between industries (MOEF 2019, 2). As mentioned previously, aiming to support technology transfer and commercialization, the initiative also promotes facilitating the transfer of knowledge and patents between universities and the private sector through asset commercialization projects and the revitalization of university technology holdings (MOEF 2019, 24).

Imposing technical standards, altering health / safety / environmental regulations

In order to set the groundwork for enhancing business performance, the Growth through Innovation initiative promotes the participation for several ministries in improving the regulatory environment for production and utilization standards of new technologies, as well as in streamlining approval processes of innovative products (MOEF 2019, 15). To support the development of convergence technology, the initiative advocates for the use of a regulatory sandbox, within which ICT solutions for industrial convergence can be tested and evaluated with respect to necessary regulations and standards (MOEF 2019, 21). To facilitate access to sandboxes, the initiative sets out to support businesses applying for regulatory sandboxes by accelerating application, review and funding processes (MOEF 2019, 43). Regulations that have the potential of creating substantial economic ripple effect, but at the same time hold the risk of causing societal conflict, are suggested to be assessed in test beds such as the smart city environment (MOEF 2019, 43). Smart city regulatory sandboxes, which can be understood as designated partially deregulated regulatory innovation zones within smart city environments, are to help overcome limitations of the current legal system in developing FIR technologies in areas such as personal information protection, sharing economy, autonomous mobility, or drone traffic (PCFIR 2019, 68). To further accelerate innovative processes through adjusting the regulatory framework for innovation, the initiative also promotes the use of the regulatory verification responsibility system and the comprehensive negative approach (MOEF 2019, 43). By implementing a regulatory verification responsibility system, the initiative aims to continuously assign regulatory changes to be verified by the relevant ministries, and to allow them to drive forward regulatory improvement processes (MOEF 2019, 43). In addition, the comprehensive negative approach, which can be understood as an approach to designing regulations on the principle of initially permitting and regulating if necessary (Ministry of the Interior and Safety, 2019), is suggested as a means of supporting ministries in autonomously discovering regulatory improvement (MOEF 2019, 43). Moreover, with the goal of adjusting regulation in accordance with future predictions and in preparation of potential risk factors, the initiative promotes to continuously expand preemptive regulatory reforms by extending the already existing “Roadmap for Preemptive Regulatory Reform”, which has been developed for the autonomous mobility field, to other future industries (MOEF 2019, 44). The I-Korea 4.0 response plan, too, suggests the provision of regulatory sandboxes and the introduction of negative regulatory approaches, aiming to allow enterprises to conduct R&D and testing in safe environments and under certain exemptions of current regulations (MSIT 2017, 71). In response to

changes related to the advent of the FIR, the response plan promotes reorganizing existing approaches and researching new approaches towards new legal issues, aiming to allow new innovations to settle by strategically adjusting regulation in accordance with predictions on future technology developments (MSIT 2017, 71). Specifically highlighting the protection of the software industry through ensuring appropriate compensation and working conditions for developers, as well as through regulations concerning user interaction technologies like content platforms or authentication systems, the response plan provides a list of suggestions outlining regulatory and deregulatory measures, including both specified technology areas, such as autonomous cars or smart grid, as well as strategic fields, such as startups or fintech (MSIT 2017, 72-4).

Aiming to protect user rights and to clarify user responsibilities through establishing appropriate legal systems and standards, based on OECD recommendation, the Growth through Innovation initiative calls for a clear establishment of government principles and policies addressing issues such as AI malfunctions, autonomous vehicle accidents, AI copyrights, or artificial robot personality (MOEF 2019, 44). In the context of AI, the PCFIR promotes the establishment of ethical standards around areas such as accountability and transparency, aiming to ensure the safe and reliable utilization of new technologies, particularly in fields related to autonomous systems (PCFIR 2019, 70). Suggesting for the government to bolster AI ethics standards that are already being formed within the private sector, the committee advocates for legally limiting R&D freedom in the AI field in cases where personal freedom or rights are being violated or the legal order is being infringed (PCFIR 2019, 70). As a means of instituting human-centered intelligence ethics, the I-Korea 4.0 response plan promotes the introduction of an AI ethics charter, as well as the establishment of a regulatory basis of AI rights infringement (MSIT 2017, 82). The ethics charter is to define standards and procedures defining the conduct in data collection and algorithm development, with the aim of preventing social prejudices to be reflected in data and AI processes (MSIT 2017, 82). To allow for remedies to be provided in case of rights infringement caused by automated AI decisions, the initiative proposes to establish legal frameworks for explanation requests, aiming to prevent various ethical issues related to areas, such as economic or gender inequality (MSIT 2017, 82).

In order to allow for super-connectedness of both private and public sectors, as well as to make full use of AI and big data technologies, the PCFIR advocates for a shift from the currently domain-oriented cybersecurity policies, which disconnect certain data environments from the internet, towards a data-oriented one, allowing for the interconnection of all data

(PCFIR 2019, 70-1). To achieve this, the committee promotes an adjustment of the current information protection policy direction, suggesting the introduction of cyber security regimes that classify data based on importance levels, allowing for the lifting of network separation and the opening of formerly classified public and financial data (PCFIR 2019, 71). In order to ensure the enforcement of cyber security regulations, the I-Korea 4.0 initiative promotes the establishment of an intelligent cyber safety net, which collects cyber threat information and, through applying AI and big data technologies, functions as an automated cyber threat response system (MSIT 2017, 82).

With the goal of enhancing competitiveness in the healthcare industry, in the light of a transition towards personalized medical care, the PCFIR promotes preemptive regulatory adjustments across the healthcare sector, mentioning areas such as approval of medical devices and pharmaceuticals, clinical research methods, and the use of personal data (PCFIR 2019, 59). To achieve this, the committee suggests strengthening approval and licensing processes through establishing dedicated organizations and increasing the number of inspection personnel, as well as to revise current legislation in areas such as personal information or bioethics (PCFIR 2019, 60). Here, too, the enablement of innovation through creating an industrial ecosystem is being suggested, and the introduction of negative regulatory methods, is being advised (PCFIR 2019, 60).

Identifying legal and institutional shortcomings in the area of blockchain technologies, specifically in regard to defining cryptographic assets and granting smart contracts, as a hindering factor in developing the blockchain industry and as a potential international competitive disadvantage, the PCFIR promotes the establishment of a legal status for cryptocurrencies along with related taxation and accounting frameworks (PCFIR 2019, 72-3). Considering its potentially disruptive impact on the finance and logistics sectors, as well as due to social resistance towards cryptographic assets, the PCFIR promotes utilizing a sandbox approach for developing the regulatory environment around blockchain technologies (PCFIR 2019, 73). As this allows for testing of new crypto technologies in a safe environment, the committee identifies this approach as a way of gaging the benefits and risks of various blockchain businesses, while at the same time improving public acceptance for cryptographic assets (PCFIR 2019, 73).

Promoting government efforts towards founding legal and institutional frameworks for data utilization, the PCFIR advocates for an update of legal protection legislation towards minimizing legal risks and uncertainties in relation to the use and distribution of personal data (PCFIR 2019, 69). The aim herein, according to the committee, should be to create a legal environment

in which personal and privacy rights of individuals are being protected, and the right of self-determination of personal information is ensured (PCFIR 2019, 69-70). Furthermore, the PCFIR calls for the clarification of rules related to data ownership and its use (PCFIR 2019, 70).

By promoting strategic regulatory reforms, the Growth through Innovation initiative aims to foster growth within the fintech industry (MOEF 2019, 18). To promote the development of new fintech approaches, particularly around blockchain technology, the I-Korea 4.0 initiative promotes the provision of financial regulation test beds, the admission of regulatory exemptions for areas that are not clearly regulated under the current law, as well as the issuing of special test permits (MSIT 2017, 44-5).

As an approach towards adjusting regulations for the evolving digital environment in the finance sector specifically, the PCFIR suggests bolstering the growth of finance firms through launching a financial regulatory sandbox, as well as through introducing sector-specific standardized open APIs (PCFIR 2019, 63). To further improve flexibility, and to allow financial firms and fintech enterprises to grow together, the committee also points out the necessity of introducing a license system that allows fintech firms to swiftly obtain essential business licenses (PCFIR 2019, 63).

Attempting to support the development and facilitate the commercialization of smart mobility technologies by adjusting the regulatory environment, the I-Korea 4.0 initiative suggests establishing test beds for autonomous cars, to adjust maritime safety regulations, as well as to review current systems in place for processing liabilities and handling insurance claims in case of accidents (MSIT 2017, 42-3).

As a means of fostering innovation in the logistics field, specifically in the domain of smart logistics and in areas where AI and robotics are being utilized, the I-Korea 4.0 initiative advocates for the development of appropriate safety assessment standards, and for revising the legal framework for logistics certifications (MSIT 2017, 45). In order to pave the way for private operation of smart logistics facilities, the Digital New Deal promotes the introduction of a smart logistics center certification system, targeting warehouses and distribution centers that are planning to implement advanced logistics operating systems and facilities (MOEF 2020a, 76).

Aiming to prevent backlash from existing industry due to disruptive developments in the startup sector, the PCFIR also suggests utilizing the regulatory sandbox approach as an overall means to support the development of startups, as they enable policymakers to thoroughly prepare administrative and legal solutions before revising laws and regulations (PCFIR 2019, 74-

5). To further support the adjustment of regulation in the startup sector, with the aim of establishing an efficient startup support system, the PCFIR suggests improving public officials understanding of the startup sector, regarding both its technologies and its performance, allowing them to simplify administrative procedures and to better assess and design the needed support measures (PCFIR 2019, 75).

With the goal of enhancing the competitiveness of enterprises in the renewable energy sector, the Growth through Innovation initiative sets out to introduce a certificate verifying enterprises' eco-friendliness in the production and supply of energy, which is to influence their standing in competitive bids (MOEF 2019, 17). Targeting to regulate hydrogen safety specifically, the 3+1 strategic investment fields strategy includes the enactment of a management act ensuring the safe use of hydrogen (MOEF 2019, 12).

Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms

In order to enhance growth within the SME and startup sector, the I-Korea 4.0 response plan suggests supporting the proliferation of a maker culture through increased government investment (MSIT 2017, 75), however, this strategy is not being further elaborated on.

Improving international competitiveness through adjusting tariff & non-tariff barriers / export restrictions / trade agreements / currency regulations, prevention of international exploitation

Attempting to discover and widen the demand between leading overseas enterprises and Korean startups, the Growth through Innovation initiative sets out to expand global matching programs (MOEF 2019, 25). By utilizing existing networks among export businesses, the initiative promotes the employment of an international open innovation scheme for small domestic enterprises, providing them with matching and exchange opportunities with large overseas companies, as well as with bases for international expansion in the form of workspaces and entry support into local startup ecosystems (MOEF 2019, 25). With the aim of fostering global fintech unicorns, the Growth through Innovation initiative promotes the support of domestic fintech companies in their overseas expansion efforts (MOEF 2019, 18). In order to promote the expansion to South Asian and South-East Asian countries specifically, the initiative promotes arranging overseas demo days in which Korean fintech businesses are to participate (MOEF 2019, 18).

Aiming to promote exports and to increase global competitiveness of the food production sector, which includes not only the production of agricultural and fishery produce, but also related industries such as food production equipment, the PCFIR promotes improving the reliability of domestic produce by establishing a quality assurance and safety platform based on intelligent technology (PCFIR 2019, 67). To secure the system's effectiveness, the committee further suggests introducing a standardized verification system for each step of the value chain and providing support to less progressive production clusters in improving their export capacities (PCFIR 2019, 67).

In addition to the prior mentioned adjustment of national regulations regarding blockchain technology, the PCFIR also promotes the initiation of an international discussion on issues related to creating a safe infrastructure and rules for the handling of cryptographic assets by financial institutions, specifically mentioning anti-money laundering regulations, similar to those of the tradition financial sector (PCFIR 2019, 73).

4.8 Public Procurement and Public Services

4.8.1 Japan

Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets

As another measure in support of the small business sector, the basic plan briefly mentions the creation of initial demand for products and services provided by startups, specifically through the procurement of products and services provided by those enterprises (CAO 2021, 33), however no further details on procurement strategies are being provided.

Public services through acquiring / maintaining / managing / innovating areas such as telecommunications / transport / construction / health services / public building

In order to build a safe future society, the basic plan sets out to intensify efforts towards the prediction, prevention, as well as response to natural disasters, which are projected to become more frequent due to climate change (CAO 2021, 29). The basic plan aims to achieve those goals by allowing for the use of advanced information processing and geospatial data technology, that interlink government agencies, academia, the private sector as well as citizens, therewith optimizing both detection and mitigation efforts based on a data cooperation approach (CAO 2021, 29). Besides the prevention and management of natural disasters, the basic plan also sets out to improve response mechanisms towards biological threats, specifically that of

the outbreak of a pandemic, by adjusting information systems on infectious diseases and through providing risk communication (CAO 2021, 30). Furthermore, the previously mentioned measures of threat prevention are also to be implemented across other areas that pose risks to safety, such as the space and marine fields (CAO 2021, 30).

The development of a nationwide 5G network is also mentioned as an important step towards Society 5.0, and it is being identified as a means of coping with the increase in necessary data volume, as well as a measure to support business around the country (JapanGov 2020, 7). In order to improve communication and to lower power consumption, the basic plan proposes the development of "next-generation infrastructure" by largely improving 5G and optical fiber networks across all regions, as well as by improving technology areas such as high-performance computing, satellite systems, or geospatial information processing (CAO 2021, 20). The plan also states the intent to make way for the development of "Post 5G" systems by further reducing latency and allowing for multiple simultaneous connections (CAO 2021, 21). Furthermore, over the course of this decade, the development of "Beyond 5G" technology for the use within both industrial and social fields is being promoted, which is characterized by a multitude of simultaneous connections, minimal power consumption, and utmost reliability (CAO 2021, 21). The Abenomics framework suggests utilizing sensor and robotics technologies to maintain infrastructure and improve its productivity, as well as applying data driven approaches to designing next-generation infrastructure (JapanGov 2020, 6). Additionally, through implementing AI and data technologies, it is stated that this infrastructure concept will make possible the provision of services catered specifically to people's individual needs (CAO 2021, 21).

The Abenomics framework also mentions digital government as a means towards realizing Society 5.0, and advocates for the digitization of all administrative procedures and services (JapanGov 2020, 7). This policy approach aims at eliminating physical paperwork, as well as the modernization of personal identification methods (JapanGov 2020, 7). As an aspect of its data strategy, in order to improve the quality of data and to ensure data standards, the basic plan requires public agencies to update their registries in respect to both consumer data as well as to those of firms (CAO 2021, 19). Facilitating administrative processes for both citizens and companies through promoting integration and cooperation, as well as through standardization and unification efforts, this strategy aims to improve the user convenience while at the same time reducing operating cost of information sharing systems (CAO 2021, 19).

Mentioning its provision as a crucial aspect in achieving societal redesign towards decarbonization, the basic plan sets out to review current policies surrounding R&D in the areas of

renewable energy supply, energy conservation, as well as nuclear power and fusion power (CAO 2021, 25). The basic plan further states its intent to improve security within cyberspace by providing R&D surrounding the prediction of and countermeasures to cyberattacks (CAO 2021, 29). Specifically, the plan sets out to implement an infrastructure system which provides information on cyber security threats, open to both industry and academia (CAO 2021, 29). The Abenomics framework also promotes the development of services regarding smart city, the provision of a nationwide 5G network, as well as smart agriculture (JapanGov 2020, 6-7), however, no further details on the implementation of those public services areas are being provided.

4.8.2 Korea

Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets

In order to improve innovative business performance by creating public demand, the Growth through Innovation initiative mentions measures such as public procurement of innovative products and services to develop the specialization of the public sector, supplier promotion plans, and government funded R&D package plans (MOEF 2019, 16-9). The initiative further suggests stimulating technology demand through creating public markets (MOEF 2019, 16), which are being identified as a means of significantly expanding public purchasing across all sectors, as well as improving technology discovery (MOEF 2019, 19).

As already touched upon previously, to support the marketization of technologies identified as growth engines, the I-Korea 4.0 response plan, too, suggests creating demand for new products and services through promoting their procurement by public institutions, particularly mentioning the acquisition of original technology (MSIT 2017, 65). The PCFIR points out the importance of the government's role in encouraging innovative activities in the AI field by creating an initial market through public procurement efforts or pilot projects (PCFIR 2019, 69). Upon selecting strategies that aim at increasing demand, their capacity of interlinking with other industries should be considered, and the committee furthermore warns of intervention activities that reduce fairness or overly distort market mechanisms (PCFIR 2019, 69).

Aiming to foster demand in the smart mobility field specifically, the I-Korea 4.0 initiative identifies various technologies for which initial markets are to be created, such as detection technology or human-mobile interfaces, and promotes the introduction of prototype procurement certifications for unmanned vehicle technology (MSIT 2017, 42). To further bolster

commercialization of mobility technologies, the initiative advocates for the establishment of exclusive use cases for drone technology, such as public flights or emergency flights, as well as the development of a publicly operated port platform for autonomous ships (MSIT 2017, 42-3). Aiming to promote R&D in hydrogen-related technologies, the 3+1 strategic investment fields strategy sets out to implement a roadmap for a hydrogen economy, envisioning it through pilot projects, and setting its foundation based on technology improvement and localization (MOEF 2019, 12). To support demand creation for SMEs specifically, the I-Korea 4.0 initiative promotes initial market creation in the SME sector through increasing priority purchases of FIR products and services by public organizations (MSIT 2017, 75). In order to achieve this, the initiative suggests including the application of FIR technologies as a factor in evaluating administrative competency of local governments, as well as to introduce an improved bidder selection model that better reflects innovativity as a deciding purchasing factor (MSIT 2017, 75). In addition, the initiative seeks to improve SME early market creation by allowing enterprises without production facilities to enter the public procurement market, and by giving preference to startups when evaluating delivery performance (MSIT 2017, 75). Besides the previously mentioned measures surrounding testing and technology evaluation, the Digital New Deal also seeks to bolster the establishment of a cybersecurity industrial ecosystem by providing growth support to cybersecurity firms in the form of pilot projects for areas relevant to digital security and cyber threat prevention (MOEF 2020a, 54). Demand is to be further created by promoting public purchasing of IoT products that have been certified as secure (MOEF 2020a, 55).

Public services through acquiring / maintaining / managing / innovating areas such as telecommunications / transport / construction / health services / public building

To support technological development in the mobility and logistics areas, the PCFIR promotes active public involvement in the development of basic mobility and logistics infrastructure, aiming to create value by allowing the private sector to discover and realize new services in the field (PCFIR 2019, 65). The Growth through Innovation initiative promotes measures around improving the environment for electro mobility, autonomous driving, real-time traffic information, and industrial drones as infrastructure that ought to be provided publicly in order to boost industrial competitiveness (MOEF 2019, 14-9). In order to innovate issues surrounding mobility, through utilizing 5G, IoT, machine learning, and sensor technology, an intelligent transportation system is to be provided that can disseminate information between vehicles and transportation infrastructure, and information on road environments, such as traffic volume or

potential hazards, is to be collected and analyzed (MOEF 2019, 31-2). Aiming to enable the adaptation of an intelligent transportation system, the I-Korea 4.0 initiative advocates for the transformation of highways into smart roads, and promotes the introduction of cooperative intelligent transportation solutions, which allow for precise operation of autonomous cars through interconnection (MSIT 2017, 51). To further improve safety in the autonomous mobility field, the initiative promotes the introduction of smart traffic signaling and information systems, which are based on real time data and IoT technology (MSIT 2017, 51-2). The Growth through Innovation initiative, too, suggests digitizing transportation infrastructure through introducing an intelligent cooperative road system, implementing IoT and sensors for railway network management, transitioning to smart check-ins at airports based on biometrics, as well as by establishing smart port maintenance and surveillance systems (MOEF 2020a, 69-70). In order to establish digital twins that allow for autonomous operation of vehicles and drones, the framework suggests creating and regularly updating digital 3D maps of both aboveground and subterranean areas and structures (MOEF 2020a, 71).

To support the industry sector in the field of distribution logistics, the Digital New Deal framework suggests expanding logistics complex centers by creating additional smart transportation hubs for joint SME use, as well as through establishing three large-scale smart e-commerce logistics bases (MOEF 2020a, 76). Shipping operations are to be fortified by creating smart SME logistics hubs in harbor vicinity, by standardizing blockchain platforms for ports, as well as by creating a digital import and export logistics platform which integrates public and private data of areas such as distribution or customs (MOEF 2020a, 77). As far as the distribution of food produce goes, the framework promotes contact-free logistics approaches such as the establishment of an integrated public food service platform, which allows for efficient and remote management of agricultural product transactions, as well as the introduction of an online auction platform for livestock, which reduces the costs and risks of livestock distribution (MOEF 2020a, 77). As another means to support development in the smart logistics field, the I-Korea 4.0 initiative promotes the public implementation of unmanned cargo robots, as well as the building of a smart port in Busan (MSIT 2017, 45-6). Moreover, the initiative promotes the establishment of a comprehensive plan for developing a smart airport operating system, aiming to increase departure rates while reducing facility costs (MSIT 2017, 52).

Aiming to spur innovation in the field of elderly care and caring for people with disabilities, the Growth through Innovation initiative sets out to expand service infrastructure towards an

integrated care model, utilizing new technologies to improve services (MOEF 2019, 34). Independent living support, specifically to households of weaker social standing, based on smart home technology is being promoted as a field in which the spectrum of public services is to be increased, and R&D support is to be expanded (MOEF 2019, 35). Furthermore, the initiative promotes expanding the development and distribution of care robots and other AI devices supporting the elderly and people with disabilities, advocating for conducting increased research, as well as for developing new service models in the robot field (MOEF 2019, 34). To further increase market demand for such technologies and to bolster the industry, the initiative advocates for equipment supporting independent living to be included in insurance coverage and welfare packages for long-term use (MOEF 2019, 34). The I-Korea 4.0 response plan promotes the development of nursing robotics and movement-supporting wearable technologies, advocating for the development of infrastructure for healthcare robots, as well as for their distribution to healthcare institutions (MSIT 2017, 52-3). To support the quality of life of dementia patients in particular, the response plan suggests providing devices that support their daily life activities, as well as making early diagnosis technology more accessible (MSIT 2017, 53). In order to establish a digital system managing welfare and citizen health processes, the Growth through Innovation initiative sets out to bolster public services in the areas social security information systems, customized healthcare, air quality monitoring, resource circulation, and providing environmental information (MOEF 2019, 35-7). By utilizing AI and big data technology, the initiative promotes the implementation of an integrated social security information system, which automatically evaluates welfare needs and possible benefits based on changes in income and other determining circumstances, such as childbirth or disease (MOEF 2019, 35). Through analyzing big data from sources such as insurance providers or health checkups, customized healthcare is promoted to be further developed and delivered, aiming to create a system that aids in discovering health hazards, as well as to treat people, especially those within high-risk groups, more proactively (MOEF 2019, 35). Applying smart welfare approaches as a means of improving the discovery of cases in which welfare provision is necessary, the I-Korea 4.0 initiative promotes the enhancement of social security information systems by utilizing big data analyses, setting out to enable the provision of customized and preemptive social security services (MSIT 2017, 54).

With the goal of supporting the development of a smart health environment, which supports public healthcare from prevention to treatment, the I-Korea 4.0 initiative promotes the establishment of a nationwide data infrastructure allowing for the open exchange of medical

information among medical institutions (MSIT 2017, 37). By doing so, the response plan aims to allow for the provision of high-end medical services through utilizing an intelligent healthcare big data system, supporting precision medicine approaches such as customized diagnoses or treatment in line with individual patients' characteristics (MSIT 2017, 37-8). Aiming to introduce smart healthcare systems and infrastructure safeguarding against infectious diseases, the Digital New Deal framework promotes the introduction of smart hospitals that allow for real-time patient monitoring, AI precision diagnostics, 1.000 dedicated respirator clinics, as well as the improvement of medical data quality through supporting its standardization and verification (MOEF 2020a, 62-3). The framework also advocates for the establishment of hospitals centered around medical data collection, and the introduction of AI-based patient monitoring systems (MOEF 2020a, 44). Furthermore, to ensure access to advanced health services to all citizens through contact free technologies, the framework suggests providing remote healthcare services through mobile devices, to disseminate devices for screening and managing chronic diseases, to issue IoT devices for assisted living, as well as to develop care robots for a variety of nursing and assistance tasks (MOEF 2020a, 63).

With the goal of ensuring public safety, safety of facilities and consumer goods, maritime and railroad safety, as well as to allow for effective disaster prevention and response, the I-Korea 4.0 initiative promotes the provision of smart safety systems based on new intelligent technologies, along with the establishment of the legal foundation for such systems (MSIT 2017, 56-9). The various solutions proposed include intelligent CCTV, tracking and patrol systems based on autonomous drones, AI-based crime analysis, online user protection systems, advanced disaster response and assessment systems, automated food quality control systems, smart maritime navigation networks, real-time train monitoring and alert systems, as well as the related safety data and training information platforms (MSIT 2017, 56-9). As a means of digitizing disaster response functions, the Digital New Deal framework promotes the implementation of smart early warning systems in high-risk districts, of intelligent flood risk notification systems across the country, of an integrated disaster resource management system based on real-time information, as well as of a drone-based forest fire protection system (MOEF 2020a, 73). In order to mitigate health risks stemming from air pollution specifically, the Growth through Innovation initiative promotes the demonstration of innovative fine dust reduction technology, as well as the implementation of smart air monitoring systems, utilizing IoT and drone technology to track fine dust levels (MOEF 2019, 36). In the national defense area, too, the I-Korea 4.0 initiative advocates for applying smart solutions to bolster command

and surveillance activities, as well as to improve combat training, logistics, and defense R&D efforts (MSIT 2017, 50-1). The smart defense approaches outlined include replacing border patrol personnel with autonomous robots and other unmanned surveillance systems, big data-based decision-making and command support services, battle simulations and tactical training based on virtual and augmented reality, equipment maintenance and repair prediction systems based on AI, as well as establishing a system to identify future key defense R&D areas (MSIT 2017, 50-1). Aiming to support the development of AI infrastructure, the Digital New Deal also promotes the development of public services around the high priority fields infectious disease prediction, medical imaging, border security, crime prevention and response, energy efficiency, quality control, and counterfeit detection (MOEF 2020a, 44).

The I-Korea 4.0 initiative promotes the establishment of a hyper-connected intelligent network environment, for the realization of which the expansion of 5G networks, the fortification of wired internet networks, as well as the improvement of IoT capacities and networks are being identified as crucial steps (MSIT 2017, 69). By expanding 5G networks, the Growth through innovation initiative sets out to increase productivity and facilitate convergence in key industries (MOEF 2019, 13). Allowing them to develop next-generation 5G technologies within a state-of-the art network infrastructure, the Growth through Innovation initiative aims to enable domestic firms to become global technology leaders in the field of 5G equipment (MOEF 2019, 12). Through providing 5G test beds, the initiative further seeks to boost competitiveness (MOEF 2019, 12), aiming to promote technologies in the area of visual reality across the defense, healthcare, and production sectors (MOEF 2019, 13). In Addition, through allowing for the application of 5G public sector devices, such as mail delivery drones, intelligent security monitoring, or administrative robots, the initiative aims to establish a base to service provision in this technology field, and therewith to create a market for innovative industries (MOEF 2019, 12). Aiming to allow for demand creation through expanding 5G convergence services, the Digital New Deal initiative promotes the provision of digital contents, such as virtual and augmented reality projects, the implementation of autonomous mobility infrastructure, such as road traffic safety systems or intelligent navigation, as well as the utilization of 5G technology for contact-free public service provision (MOEF 2020a, 43).

As an approach towards reducing greenhouse gas emissions, the I-Korea 4.0 response plan advocates for publicly supporting the development of related services, setting out to enhance clean energy production and to create new businesses by improving renewable energy distribution through utilizing IoT technology, while promoting solar energy solutions in order to

drive forward the electromobility industry (MSIT 2017, 44). Aiming to improve overall environmental protection and to bolster new industries that address global change and environmental pollution, the initiative promotes the utilization of technology based on big data, AI, and IoT, aiming to monitor and forecast developments in the fields of fine dust and environmental pollution in real-time (MSIT 2017, 54-5). Furthermore, with the goal of bolstering resource circulation systems and processes, the initiative supports the development of modern recycling technology, suggesting aiding the commercialization of innovative recycling technologies, such as IoT-based waste treatment systems, by utilizing them in public facilities, as well as by promoting domestic firms engaging in R&D of environmental technologies (MOEF 2019, 36). Aiming to support eco-friendly decision-making, the initiative promotes the use of AI and big data technology to assess the environmental impact of new development projects, and to construct an information platform through which environmental data can be linked, analyzed, and utilized to make future predictions MOEF 2019, 37).

With the goal of improving government capabilities though utilizing 5G and AI technologies, the Digital New Deal proposes to implement contact-free customized administration, allowing for improved citizen interaction around areas such as making claims and taking part in petitions through online channels, as well as granting easy access to an integrated welfare platform and welfare information, or disaster early warning systems (MOEF 2020a, 48). To allow for those systems to work securely and seamlessly, the framework proposes to utilize blockchain technology, to make administrative platforms accessible through a public cloud, as well as to allow for smart work in the public sector by establishing an exclusive 5G network for administrative use (MOEF 2020a, 48-9). Aiming to further innovate national services, the Growth through Innovation initiative promotes the use of data to improve citizen satisfaction through providing public services based on individual needs (MOEF 2019, 33). Seeking to establish an intelligent public service system that can identify individual needs and customize services accordingly, the initiative promotes a one-stop consultation platform based on an AI chatbot that is able to provide civil services from across all levels of government, regardless of location or time (MOEF 2019, 33). The initiative furthermore advocates for continuously probing new fields in which data can be utilized to innovate public services to citizens, specifically mentioning the topic of real-time information provision in areas such as mobility or water quality (MOEF 2019, 33). In addition, through enhancing cloud technologies and activating the cloud market, the 3+1 strategic investment fields strategy also envisions the establishment of a

cloud-based e-governance platform, along with the potential use of private cloud services to undertake administrative tasks (MOEF 2019, 11).

Aiming to improve management processes for essential infrastructure by employing AI and 5G technology, the Growth through Innovation initiative sets out to enhance water and sewage systems through implementing intelligent management systems, and to improve retiree facilities and disaster response systems by utilizing digital twins in order to enable them to be more data-driven in their management approaches (MOEF 2019, 32). With the goal of establishing a remotely controlled water resource management system, the Digital New Deal framework advocates for implementing automated drainage and real-time monitoring systems for rivers, for applying automated sluice control systems at reservoirs, as well as for establishing smart safety management systems for dams by utilizing drones (MOEF 2020a, 72). Additionally, the I-Korea 4.0 initiative plans to apply IoT-based monitoring and maintenance systems that ensure the safety of water supply and sewage systems, and that improve overall water quality and facility management activities (MSIT 2017, 55).

In order to improve efficiency of energy generation and consumption, the I-Korea 4.0 initiative promotes the nationwide expansion of the smart grid, setting out to implement intelligent power metering systems across all businesses and households, as well as to opening a small-scale intermediate market for electric power (MSIT 2017, 43-4). The Growth through Innovation initiative promotes the expansion of smart grid infrastructure as a means through which the public sector can support private businesses in enhancing their competitiveness (MOEF 2019, 17). The initiative further aims to boost hydrogen infrastructure by establishing a hydrogen ecosystem, which is intended to be facilitated through installing charging stations across major cities and transportation hubs (MOEF 2019, 13).

The I-Korea 4.0 initiative identifies the smart city approach as a means of solving urban problems and sets out to construct new smart city sites in cooperation between public and private actors, as well as to establish urban management systems based on big data analysis around areas such as safety and mobility (MSIT 2017, 49). The response plan also suggests utilizing smart city technologies to revitalize local city environments, advocating to create an expert committee and to launch pilot projects in order to design a nationwide revitalization approach (MSIT 2017, 49-50). To further facilitate the construction of smart cities, the initiative suggests bolstering the construction industry by supporting a transition to intelligent construction approaches, and to promote the creation of smart living by developing model homes (MSIT 2017, 50). In order to support the construction of smart city environments, the New Digital Deal,

promotes the development of a national smart city model, and to disseminate it to local governments through trial projects based on existing smart city environments, mentioning a number of target functions such as traffic monitoring, crime and disaster prevention, demand-based public transportation, or drone delivery (MOEF 2020a, 74-5).

As a means of innovating overall public infrastructure through digitization, the Growth through Innovation initiative aims to digitize national geographical information, instate an intelligent transportation system, and enable AI based infrastructure management (MOEF 2019, 31-2). As far as the provision and management of digital geographical data goes, the initiative promotes the development of spatial information technology, the creation of a three-dimensional geographical grid to support infrastructure maintenance, as well as to further refine digital land management approaches through simulation projects within virtual city models (MOEF 2019, 31).

4.9 User Involvement in the Innovation Process

4.9.1 Japan

Enabling involvement of relevant actors, organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, interlinking with emerging markets, lead users, crowdsourcing activities

By involving various actors, particularly through citizen participation, the basic plan seeks to bolster co-creation of knowledge and to improve science communication (CAO 2021, 71). Efforts stated to promote citizen participation in the policy process, as well as to strengthen technology communication, include gathering of public opinion, public dialogue, and collaborative activities utilizing technologies necessary for realizing Society 5.0, such as AI or IoT (CAO 2021, 71). The basic plan sets out to promote cooperative research activities between R&D organizations and actors such as NPOs, NGOs, SMEs, independent researchers, or public organizations, as well as with the general public through citizen science research (CAO 2021, 72). To promote research activities that are based on co-creation with the public, the basic plan identifies technology communicators as HR that are indispensable in connecting various actors (CAO 2021, 72). Ultimately, the goal is to create an environment in which various actors are encouraged to participate in the innovation policy formation process (CAO 2021, 72). The fostering of a public understanding of every single citizen's efforts towards realizing

decarbonization is being pointed out as a crucial aim by the basic plan (CAO 2021, 26). To further engage consumers in decarbonization efforts, the basic plan advocates for encouraging behavioral change through measures such as incentivizing the reduction of CO2 consumption, which is being proposed to be implemented in the form of CO2 reduction credits based on blockchain technology (CAO 2021, 25-6). The basic plan also suggests that lifestyle changes can be promoted through educating people and through providing a support system to consumers, as well as by emphasizing their role as "prosumers" - consumers who also take part in the production process (CAO 2021, 25).

4.9.2 Korea

Enabling involvement of relevant actors, organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, interlinking with emerging markets, lead users, crowdsourcing activities

With the goal of implementing a safe and reliable consumer-oriented food distribution system, as well as to create infrastructure allowing for personalized consumption, the PCFIR promotes the enhancement of consumer participation in food production and distribution processes through allowing for various forms of digital engagement, as well as through improving consumer rights and representation (PCFIR 2019, 66). The committee suggests that through utilizing traceability technology, such as blockchain, food distribution safety can be improved, risk factors in the production and consumption cycles can be mitigated, and consumer rights can be protected by safeguarding against transaction fraud (PCFIR 2019, 66). To support government policy in ensuring innovation sustainability, the PCFIR also mentions smart city solutions as another means to involve citizens in the creation of an innovative ecosystem (PCFIR 2019, 67). To that end, the committee suggests creating smart city ecosystems based around companies and citizens alike, and to involve consumers of urban services in urban development by taking into consideration their ideas on how to improve existing services and infrastructure (PCFIR 2019, 67). In order to prepare for potentially disruptive changes in the mobility and logistics industry, the PCFIR promotes defining a concrete vision and to formulate institutional improvements in cooperation between the public and private sectors (PCFIR 2019, 64). Aiming to identify priority policy fields, as well as to assess the public perception of new mobility approaches, the committee suggests utilizing smart city environments as test beds for new

solutions in the field, providing the opportunity for people to experience them in real life (PCFIR 2019, 64).

In addition to the previously mentioned adjustment of rules and standards for future industries and new technologies, the Growth through Innovation initiative also seeks to support and foster public debate on ethical issues in connection to the FIR (MOEF 2019, 44). To promote the debate on ethical norms in an intelligent information society, the initiative aims to motivate public participation in discourse around topics such as the prevention of dysfunctional intelligent information, or the design of human-centered ethical policies (MOEF 2019, 44). As another means to adjust the regulatory environment in light of expected technological changes accompanying the FIR, the I-Korea 4.0 initiative, too, suggests stimulating social discussions on existing and future legal frameworks, stating areas such as AI malfunctions, human responsibility in handling intelligent technologies, or property value of data as topics that hold relevance in this regard (MSIT 2017, 71). The initiative furthermore proposes to establish the guidelines regarding human-centered intelligence ethics, which I have outlined earlier on, through social discussion between developers and users (MSIT 2017, 82). In order to further improve measures taken towards protecting personal information that is part of the previously described big data support system, the initiative also promotes preparing regulations after subjecting the issue to public debate, mentioning de-identified and consent-based personal information provision as possible answers to concerns in regard to privacy protection (MSIT 2017, 70).

To further make sure that everyone can benefit from new technologies, the PCFIR promotes the utilization of public design to put people at the center of the technology planning stage, aiming to expand the public use of innovative technologies improving the quality of life (PCFIR 2019, 58). To achieve this, the committee suggests applying the living lab approach, a technology innovation method based on user participation, which enables the industry sector to better understand welfare demand (PCFIR 2019, 58). Additionally, the PCFIR suggests for the government to create an institutional foundation that allows for the use of advanced care technologies, such as robots, in public services (PCFIR 2019, 58).

5. Analysis

5.1 Outline: Analysis

Aim of the analytical chapter is to examine the policy approaches identified in the empirical chapter, and to determine whether the possible policy instruments, as outlined by the analytical framework, are being addressed by Japan's and Korea's policy strategies, or whether they are not being applied. In each section, I will contrast the policy instruments used by the two countries and provide an overview of the findings. Concludingly, in the last section a complete summary of this chapter will be provided in the form of an overview of the findings according to the analytical framework.

5.2 Knowledge Creation, Information Diffusion, and Skills

5.2.1 Creation of Knowledge and Public R&D

Direct funding, competitive research funding, block grants

As far as the direct funding of public R&D goes, the provision of a university fund and improvements to administrative processes and accessibility of funding systems are being focused by the Japanese FIR policy frameworks. To further support public research institutions, the issuance of bonds and granting more flexibility in using indirect expenses covered by public funding are being suggested. Current funding schemes are furthermore to be reviewed, along with university accounting standards currently in place. As a means of bolstering public support to private universities, the improvement of subsidy allocation processes is being advocated for.

Although the introduction of a R&D investment platform is briefly mentioned in the I-Korea 4.0 response plan, no specifics on public R&D funding were identified within the policy frameworks provided by the Korean government.

Adjustment of research governance & scientific education, statutory regulations of research institutions

The frameworks of both Japan and Korea focus on autonomous administration and resource allocation, adjustment of personnel development, and the evaluation of those efforts to support the governance of research institutions and related statutory regulations. Japanese strategies are centered on autonomy in internal resource allocation, adjustment of personnel selection mechanisms and salaries, as well as digitized management and administrative processes, while

Korean policy approaches aim at creating an overall researcher-centered environment through adjusting review and evaluation systems, by allowing for self-sustainability and competitiveness in the university sector, and through restructuring support systems for autonomous innovation activities.

The Japanese frameworks put additional emphasis on supporting emergent research and young researchers, as well as on the importance of takeover and continuation of innovative activities through public organizations in case of discontinuation of private R&D in high priority areas. Korean approaches, on the contrary, also include the modernization of curricula as part of their strategy to adjust scientific education.

Provision of physical research infrastructure

Regarding the provision of physical research infrastructure, while no policy feedback has been provided by the Korean government's strategies, the Japanese frameworks have stated the necessity to improve academic infrastructures. The formulation of guidelines for the sharing of research facilities, including equipment and research premises, is currently ongoing, and is to be carried out in coordination with universities and public R&D institutes. The rollout of a nation-wide centralized system for infrastructure sharing inquiries is also in planning. As a specific infrastructure provision project, the shared use of the supercomputer "Tomitake" is being pointed out.

Promoting multi- & interdisciplinarity, promoting international cooperation

The strategies proposed by the Japanese government to bolster multi- and interdisciplinarity in the R&D field include the fusing of fields by fostering joint and inter-university research, both domestically and internationally, and the overall aim to create comprehensive knowledge by combining natural sciences with humanities and social sciences through targeted funding and integratory measures. Such measures are also to be spread beyond the boundaries of the university sector through the introduction of a research support system. To strengthen international R&D cooperation, improvement of transnational research funding mechanisms, increase of international joint research projects, bolstering international exchange of researchers and students, furthering transnational academia-industry collaboration, and the establishment of an international research network is being brought forth.

Besides stating the general intent to remove barriers between academic fields in order to allow for the development of convergence technology, around this policy instrument, too, no mention is to be found within the Korean policy frameworks.

5.2.2 Information Diffusion and Technology Adoption

Capacity building, promoting technology improvement, provision of access to testing facilities, incubation activities, provision of technology expertise & consultancy services, enable commercialization of innovation through technical & financial support, awareness-raising

As means to build capacity, support technology improvement, raise awareness, and enable testing and demonstration activities, both the frameworks provided by the Japanese and Korean governments promote the country-wide creation of smart city environments, as well as the temporary deregulation in dedicated zones. In addition, the Korean strategies also suggest implementing large-scale technology development projects, facilitating public R&D investment and resource allocation, as well as to substantially boost testing and demonstration through a wide amount of measures such as providing technology-specific demonstration equipment, test beds and model smart factories, or access to large scale industry demonstration spaces.

Both countries' frameworks focus on supporting SMEs and startups through providing technology expertise and consultancy, however, while Japanese strategies focus on creating a startup ecosystem based around universities and government agencies across the country, the Korean strategies suggest a broad number of measures such as implementing innovation support centers, providing customized technology development support, or bolstering commercialization through supporting localization of R&D equipment. In addition, the Korean frameworks also propose technical innovation support through bolstering data-based development and business smartization. The suggested technical support instruments include measures such as the creation of industry cloud infrastructures, establishing industry data platforms and data centers, providing access to commercial information systems, and instituting agricultural and fishery resource management systems.

Improve accessibility of scientific data through open science, generate spillovers, interlinking of different research fields

To improve the accessibility to scientific data and to allow for the utilization of research data across fields, both the strategies presented by Japan and Korea suggest the introduction of an openly accessible centralized cloud-based scientific data platform on a national basis, along with the necessary measures to secure usage and to encourage data sharing among users. While the Korean platform is to be further reinforced by merging it with national science services and through integrating AI-based R&D support functions, the Japanese solution is to be enhanced

through also providing government data, such as spatial information, and it is further identified as a possible means of supporting evidence-based design and analysis of future policies through systematic data collection.

Provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations

To enable collaborative research, both Japan and Korea emphasize the creation of a data ecosystem which allows for information sharing, distribution, and access across fields and sectors, as well as the joint use of data between both private and public actors. To further enhance this data infrastructure, both countries suggest providing specialized public support for system management and maintenance, as well as to adjust rules to strengthen user rights and data sharing.

In addition, the Japanese policy frameworks also promote the establishment of research centers, which are to boost research potential and flexibility of national universities through supporting joint research, as well as to improve international research cooperation through enabling transnational exchange. The fostering of technology agility and openness as a means of supporting innovation activities is being suggested, and the creation of open innovation bases allowing for public-private innovation collaboration is also being promoted. The Korean frameworks, on the other hand, advocate for the creation and revitalization of spin-offs by establishing university affiliations, easing regulations, and by increasing customized growth support, as well as the creation of R&D clusters and regional innovation support through on-campus industry-academia cooperation.

Management contracts between private & public organizations, public-private partnership

The strategies of both Japan and Korea to facilitate public-private partnership are based around the creation of data collaboration platforms: The Japanese approach suggests enabling cooperation through providing a data collaboration platform for both private and public actors, and the construction of an open data interface is also being suggested. The Korean policy frameworks advocate for the systematic and safe use of a collaborative big data platform by establishing a consultative chain in charge of data management and maintenance functions, and by improving data protection regulations. Additionally, to further incentivize data transactions between public and private actors, the Korean strategies suggest establishing processes

regarding data quality, data standards and interlinking of data, as well as through providing standard contracts and transaction guidelines.

Besides utilizing data collaboration, the Japanese policy approaches also promote the utilization of the smart city framework as a driver for public-private cooperation, further details on how to facilitate this are however not provided.

Establishment of technology transfer alliances between research organizations, provision of knowledge networks & knowledge markets

Whereas no policy approaches were identified in respect to technology transfer alliances or the provision of knowledge networks and knowledge markets among the strategies provided by the Japanese government, the Korean frameworks provide a strategic approach to both those areas: to facilitate technology transfer and patent commercialization processes, the initiation of a creative asset project has been suggested, supporting technology transfer from universities in areas such as prototype production, technology discovery, or business model design. Additionally, university technology holding companies are to be revitalized through directly providing technology commercialization support to their subsidiaries and by adjusting stock ownership regulations, and the implementation of a platform enabling private businesses to undertake investment, planning, evaluation and technology transfer activities is being promoted. As far as knowledge networks and markets go, the creation of an open innovation platform as a space for discussion for experts across all fields is being advocated for, and, through providing access to an open API that allows firms to acquire outside data, data distribution and utilization between businesses is being promoted. Moreover, through establishing a national big data support system covering all industries, new industry core data is to be accumulated and distributed to private businesses.

5.2.3 Human Capital and Skill Development

Regulation / organization / funding of national education system

As far as overall changes to the national education system go, both the Japanese and Korean policy frameworks promote to further emphasize education in areas surrounding ICT and related sciences, to improve teaching capabilities in those fields, as well as to bolster educational processes through data utilization.

Primary and secondary education in Japan is to be strengthened by introducing new curricula that encompass learning across a variety of fields based on the STEAM approach, by launching mandatory programming classes from elementary school level, and by assessing the

weight of scientific and cross-disciplinary skills in university entry examinations and employment processes. In the case of Korea, the measures proposed to improve the primary and secondary education systems are the expansion of elective courses and convergence between subjects, a comprehensive training reform for teachers, the enhancement of school support systems, giving schools more autonomy in identifying educational needs, as well as the improvement of online and remote learning.

Tertiary education in Japan is to be adjusted to allow for better university selection processes, a more individualized choice of coursework, and the development of curricula that support student self-actualization. Also, new HR development is to be included in university funding schemes. In order to advance tertiary education in Korea, particularly aiming at fostering technology convergence skills, the provision of support to institutions delivering basic software education, the establishment of software convergence colleges and specialized graduate school programs for semiconductor convergence, the expansion of AI graduate and postgraduate courses, the improvement of remote learning capacities, and, more generally, the expansion of master's and doctoral degree programs focusing on FIR fields are being promoted.

Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing

In order to develop skills that meet the needs of FIR businesses, the Korean policy strategies advocate for HR development support through publicly providing vocational training schemes and vocational colleges. Aiming to further bolster vocational training approaches, training schemes in cooperation with industry actors, through channels such as joint training centers or seminars, are being suggested. To enable remote vocational training, public training institutions are to be supported by implementing a mart training and education platform, and private online vocational training activities are to be supported through providing access to public education platforms, consultation on curricula adjustments, additional training of instructors, as well as through enabling cooperation with public educational institutions on developing short-term courses. In addition, the Korean frameworks also promote fostering cooperation between industry and apprenticeship schools as a means of developing highly skilled talent through apprenticeship type training.

For the case of Japan, no approaches regarding these policy instruments could be identified within the assessed policy frameworks.

Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators

As measures to nurture managerial development and leadership in the startup sector, Japanese policy approaches suggest fostering an environment which encourages individuals with appropriate capacities to take on management roles, as well as to utilize the startup ecosystem as a channel to provide country-wide entrepreneurship programs.

Identifying local business accelerators and national technology promotion initiatives as measures to improve the overall level of HR expertise in SMEs, as they allow them to foster leadership and to optimize operational processes while also supporting the development of experts and increasing added value, their provision is being suggested by the Japanese frameworks.

As far as the fostering of entrepreneurship and related skills or the provision of business accelerators go, no policy details have been provided by the Korean frameworks.

Focusing broader humanitarian education / multi- & interdisciplinarity / lifelong learning / technical literacy

Within the Japanese frameworks, the development of HR with additional knowledge in the fields of humanities and social sciences through graduate programs is being promoted, as well as the modification of undergraduate programs to allow for more versatility in their curricula, for coursework outside home faculties, and for double major degrees. To support multi- and cross-disciplinarity within secondary education, the STEAM approach is being suggested. While the promotion of humanitarian education is not mentioned in the Korean policy strategies, the fostering of multi- and interdisciplinary is being approached by setting out to develop convergence HR who are able to fuse smart technologies with current industrial models. To achieve this, the introduction of specialized curricula surrounding convergence education in universities is being proposed, and further spreading of the STEAM model across primary and secondary schools, including the provision of science spaces and future career counseling, are being promoted.

With the goal of supporting lifelong learning, the Japanese frameworks suggests supporting recurrent education for employees through publicly providing flexible hybrid education approaches in cooperation with universities, educational leave schemes, digital content such as open online courses, encouragement of businesses and universities to engage in recurrent education, as well as through, more generally, creating a system that encourages re-learning activities. The Korean policy strategies recognize lifelong learning as an important factor in aiding

both currently employed and unemployed workers, as well as in reacting to changing demands in future HR requirements. The measures proposed to facilitate continuous learning activities, besides making it more affordable and accessible overall, include the establishment of lifelong learning bases, the introduction of a university-led lifelong learning activation project, the creation of an intelligent teaching and learning platform, the establishment of polytechnic schools specializing in ongoing education, the enhancement of educational measures supporting career change, support for remote learning, and the overall readjustment of lifelong learning strategies to focus on skills required in future industries.

To enhance technical literacy within the workforce, the Korean frameworks put forward various technology specific approaches such as the implementation of AI and AI convergence training programs for SMEs and venture businesses, the provision of manufacturing training within the smart industrial complex, or the establishment of specialized smart port training schemes. Stating the intent to enhance technical literacy regarding FIR technology, particularly the fostering of talent possessing knowledge in both the virtual and physical worlds, the Japanese government's policy strategies propose to build HR capacity through cross-sectoral cooperation, while also evaluating industry HR demands.

Preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation

The Japanese and Korean policy frameworks both promote the improvement of working conditions for researchers, advocating for measures such as implementing more appropriate compensation schemes and the strengthening of recruitment processes through academia-industry cooperation. The Japanese frameworks do however provide some more detail in these areas, suggesting a variety of possible approaches towards improving researcher working conditions, such as the encouragement of fixed-term employment systems, the expansion of research fellowship schemes and research scholarships, or the introduction of a standardized tenure track system.

To allow for more flexible work styles, both countries' policy approaches promote a shift towards increasing work autonomy, such as remote work or simultaneous engagement in multiple jobs, for more flexible working hours, as well as for the implementation of a wage system that gages rewards based on created value. The Korean frameworks further suggest to specifically improve social security for professions at risk due to technological changes, to strengthen

basic worker rights regarding health and safety, and to introduce a multi-layered decision-making structure enabling cooperation between social partners and businesses on HR issues.

Another field that is shared by both Japanese and Korean frameworks is HR mobility: Both countries' frameworks seek to support HR mobility and to facilitate job change by improving capacities of personal career counseling, while also providing career change information via an online platform. According to the Korean frameworks, this is to be further enhanced by individualizing the information provided, by big data- and AI-based job matching, by implementing online consultation chatbots, and through providing company information systems.

An aspect of this policy instrument that has been covered by the Japanese frameworks only is the improvement of women's participation: measures proposed to increase female participation in the labor market include the promotion of paternity leave and encouragement of male participation in domestic activities, the improvement of public assistance to single parents, the provision of additional education upon reentry after maternity leave, the extension of leadership programs held by female business scholars, and the overall improvement of female healthcare and prevention of crimes against women. Furthermore, diversity in the research field specifically is to be supported through clarifying career paths and introducing female role models, making institutions accountable for the ratio of female doctoral students, adjusting maternity leave regulations, and providing on-campus childcare services. On a similar note, other measures of increasing access to the labor market promoted by the Japanese FIR strategies include support to senior citizens through measures such as job matching and enabling employment beyond retirement age, as well as support to young people by providing free education to members of low-income households and by expanding scholarship programs.

Issues strongly focused by the Korean frameworks are social security and employment stability: to ensure those, a wide spectrum of approaches is being prompted, including the introduction of a universal insurance system without blind spots, guaranteeing security regardless of employment type, the establishment of a sound social security fund, improving social insurance coverage by increasing payment amounts and periods, extending duration of unemployment coverage duration, providing support to people not covered by employment insurance, the expansion of health and accident protection insurances, or the introduction of a minimum wage for people of all employment types, just to mention a few. The Korean frameworks also state the necessity to make sure that the spoils of technological advancement are shared equally by institutionalizing the social security system, discussing the introduction of a system in which

beneficiaries of technological advancement are obliged to assume financial responsibility for reducing inequality, along with the potential introduction of a basic income.

Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility

As measures to secure the inflow of foreign talent and to facilitate access for foreign workers to the domestic labor market, the Japanese frameworks suggest attracting foreign professionals by simplifying visa procedures, by inducing a Japanese Green Card program, by introducing a new residence status for highly skilled workers, as well as through improving the overall quality of life for foreign workers residing in Japan. To attract overseas research personnel specifically, and to improve brain circulation, the Japanese strategies further suggest improving efforts towards the hiring of international researchers, to internationalize research bases and administrative processes, to adapt salaries and working conditions to international standards, and to provide living support to overseas researcher personnel.

As far as the enhancement of global mobility for Japanese researchers and students goes, the improvement of exchange systems is being promoted. Exchange is to be facilitated through building the previously outlined international research network in Japan.

Although briefly mentioning inviting technology talent, reinforcing global networks, and strengthening R&D competitiveness as areas in need of improvement in order to attract foreign talent, no concrete policy approaches are being provided by the Korean frameworks.

Strengthening support for external competence building, enable HR development through university-industry relations

Korean approaches towards supporting external competence building and HR development through connecting universities to industry actors focus on cooperative training through giving access to external education, and through allowing for on-site training. The measures proposed to support external education include regional technology cooperation programs, contract departments within universities, and providing access to specialized education such as industry-academia information security graduate schools. On-site training, on the other hand, is to be facilitated through measures such as local cooperative training projects, conducting joint vocational training with large numbers of participants, providing access to industry-relevant workspaces, and educational visits, as well as by generally supporting training collaboration among businesses. The Korean strategies also point out the importance of giving appropriate incentives to participate in external education activities to all involved actors, of supporting both the

creation of new jobs and innovating existing professions, and of supporting startups and SMEs in this regard. The possibility of conducting matching of new research HR through industry-academia cooperation is also being mentioned.

The measures in support of external competence building and university-industry HR development promoted by the Japanese frameworks, somewhat contrarily, focus on enhancing personnel exchange, improving recruitment efforts, and on utilizing external lecturers. Aiming to improve the innovation process through encouraging personnel exchange between educational institutions and the industry sector, measures such as the introduction of a cross-appointment system, or the enablement of academic HR to expand their careers to the industry sector and vice versa, are being proposed. Recruitment and matching efforts are to be improved surrounding the matching of doctoral degree holders to private sector career paths, and researchers are to be allowed to explore potential application of their research through participating in industry-academia collaboration activities. In order to support career development from an early age, the Japanese frameworks also suggest establishing a system allowing for increased participation of external lecturers from both industry and academia in high school teaching, which is to be facilitated through revising external lecturer certification guidelines, as well as through issuing special licenses and introducing instructor systems.

5.3 Regulatory Framework and Business Environment

5.3.1 Financial Incentives to Enterprises

Direct stimulants in the form of economic subsidies & investment, improving capital fluidity

Both countries' policy frameworks promote the provision of direct economic stimulants to businesses as measures to support FIR innovation. The Japanese strategies promote the provision of large-scale direct financial support of R&D in the form of gap funds, the issuing of financial support for collaborations between corporations and venture businesses, and to put in place systems to evaluate eligibility for public funding based on innovation capacity and the created social value. Korean strategies set out to enable direct financial support through introducing exclusive growth funds, providing technology specific funding, applying long-term policy financing strategies, initiating a voucher program, and through establishing cooperation among public actors on designing new financing policies and on distributing funds. In addition, Korean frameworks emphasize public funding towards SMEs and venture business, proposing

to increase the ratio of R&D funding allocated towards FIR ventures, to individualize funding schemes depending on the size of the enterprise, to introduce a scale-up fund and an adventure fund, as well as to enhance the availability of initial funding and to simplify related administrative processes.

Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding

Whereas no strategies in this regard could be identified within the Japanese policy frameworks, the Korean frameworks have outlined a few approaches towards providing financial support through facilitating access to loans: the measures suggested are the introduction of a credit model which integrates credit evaluation and technology evaluation in one place, the implementation of credit review models that take into account technology development process and qualitative growth factors, the issuing of loans to enterprises attempting to switch from a conventional manufacturing system to a smart one, valuation and default support to banks issuing intellectual property mortgage loans, as well as abolishing the joint guarantee system in order to ease access to loans and funding for startups.

Indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings

To support private investment, particularly in venture businesses and startups, the Korean frameworks suggest adjusting current regulations by generally revising current venture investment regulations and processes, by designing policy financing strategies that support private investment, by introducing an indemnity system, and by easing crowdfunding restrictions and increasing maximum investment caps. Also, investment in intellectual property is to be further encouraged, and a support system for technology investments is to be provided. In addition, the Korean strategies also advocate for directly supporting private venture funding activities through measures such as parent investment or follow-up management. To support public SME listings, access to the Korea New Exchange is to be made easier and more flexible, and the total amount of offerings is to be increased.

Although the Japanese frameworks provide only little input on the policy instruments in this bracket, the formation of public venture funds as a means of fostering startup innovation is

being brought forth, and the hosting of seminars providing information on FDI opportunities is being promoted.

Tax benefits & relief aimed at supporting R&D activities such as tax reductions / tax exemptions / tax incentives / tax credits

While the tax relief schemes proposed by the Japanese frameworks evolve around tax reduction, the strategies put forward by the Korean frameworks focus on tax credit and tax deduction mechanisms as measures to support innovation and R&D activities. More specifically, the Japanese strategies promote alleviating the corporate tax burden by reducing corporate profit taxes and property taxes for SMEs investing in new technologies, as well as by reducing overall corporate taxes through shifting towards a more growth-oriented tax scheme. The Korean frameworks, on the other hand, emphasize measures such as the provision of tax credits for R&D efforts towards developing new technologies, the implementation of R&D tax credits to overseas enterprises controlled by domestic companies, and higher tax deduction rates for enterprises engaging in foundry R&D.

5.3.2 Competition, Intellectual Property, and Standards

Antitrust policies targeting cartelization / vertical restrictions / merger regulation, interconnecting new enterprises with persistent monopoly

Both Japan's and Korea's policy frameworks put emphasis on creating an environment in which established companies and new ventures can compete freely among each other, and which encourages collaboration under fair conditions. As far as regulatory measures go, both countries' frameworks promote the adjustment of monopoly abuse regulations and rules that ensure collaborative activities under fair circumstances, as well as giving support to SMEs in aspects surrounding ownership, business transition, and mergers. To further support vertical business partnerships Japan, as a means of accelerating the innovation cycle, suggests introducing collaborative systems in which larger companies contribute data and knowledge on technology utilization, while smaller companies provide new ideas and prototypes. In Korea, the interconnection of new and existing enterprises is also to be facilitated through utilizing a data and resource sharing platform, as well as through fostering cooperative value chains and by providing access to smart factory environments as spaces for cooperation.

Regulating intellectual property through patent law / regulating knowledge transaction / knowledge rights / regulating knowledge co-creation / taxation schemes incentivizing intellectual property assets

While both countries' policy strategies have suggested measures towards the protection of intellectual property and its transfer, Japanese strategies focus on initiatives regarding knowledge transaction and data collaboration, whereas Korean strategies emphasize the improvement of patent laws. To support knowledge transactions, the Japanese frameworks suggest ensuring the free but safe flow of data between private actors by improving data governance systems and investigating data exchange institutions, as well as by instituting rules regulating the use of data and ensuring its authenticity. Data collaboration in the private sector is to be bolstered through measures such as generally improving cyber security systems, auditing current security regimes, introducing a tax break scheme benefitting data sharing, as well as by providing data utilization contract guidelines and encouraging their use. Although also briefly mentioning the need to adjust regulations in regard to data sharing and data collaboration, the Korean frameworks strongly focus on adjusting the current patent system as a means to foster innovation: the measures suggested to do so are modernizing it to better secure intellectual property of new technologies, improving investigatory measures, introducing punitive compensation for violation of intellectual property rights, regulating ownership rights of intellectual property created by AI, as well as revising current patent examination criteria and systems to prioritize the processing of FIR-relevant technologies.

Imposing technical standards, altering health / safety / environmental regulations

In the light of the emergence of new technologies and business models, in order to allow lawmakers to discover and evaluate which regulatory reforms are necessary, the frameworks of both Japan and Korea suggest conducting regulatory testing through measures such as the provision of regulatory sandbox environments, the creation of strategic special zones, or the establishment of various types of test beds. Additionally, the Korean frameworks also suggest allowing for continuous verification of the relevant ministries by utilizing a regulatory verification responsibility system, as well as to preemptively pass new regulations using a comprehensive negative approach.

As far as concrete areas go in which change of rules and standards are being proposed, both frameworks promote the protection of personal data through measures surrounding increased transparency or ensuring the right of self-determination. The Japanese strategies additionally emphasize the issue of decarbonization, promoting measures surrounding the improvement of

environmental protection, sustainable food production, and the inclusion of environmental factors in investment processes. Korean frameworks, on the other hand, are further proposing regulatory adjustments in the areas AI, cyber security, smart healthcare, blockchain, personal data, fintech, finance, smart mobility, smart logistics, hydrogen, renewable energy and SMEs, suggesting a wide variety of measures such as bolstering AI ethics, intelligent cyber safety, logistics center certification system, or the establishment of legal status for cryptocurrencies, just to pinpoint a few.

Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms

The soft approaches presented within the Japanese frameworks include the formulation of a corporate governance code, as well as that of a stewardship code: With the goal of strengthening governance processes of group companies, a governance code was released in the form of a set of guidelines supporting decision making among the participating firms. Objective of designing a stewardship code was to promote a mutually profitable dialogue between investee companies and investors.

Within the Korean frameworks, besides a brief mention regarding the proliferation of a maker culture, no specific approaches could be identified regarding this policy instrument.

Improving international competitiveness through adjusting tariff & non-tariff barriers / export restrictions / trade agreements / currency regulations, prevention of international exploitation

Improving competitiveness by directly bolstering international business expansion of domestic firms is an aim pursued by both countries' FIR strategies. The Japanese frameworks suggest enabling international collaboration through matching projects with overseas businesses, by easing administrative burdens for transnational firms, through increasing international infrastructure investments, and by further supporting overseas activities of SMEs through information provision and introductory conferences. The approaches promoted by the Korean frameworks also advocate for the expansion of global matching and exchange programs, as well as the provision of overseas business entry support through measures such as holding demo days or giving small companies access to international workspaces.

In addition, the Japanese frameworks aim to further fortify the standing of domestic businesses on the global stage through improving international interconnectedness, strengthening international standard-setting and intellectual property protection efforts, nourishing tourism

to Japan and export of agricultural goods, as well as through trade agreements. The measures proposed to achieve this include the introduction of a secure global data distribution network, the bolstering of international standard setting efforts through training specialized HR and awareness-raising, instituting systems regulating technology leakage, setting up destination management organizations for tourism development, the increase of agricultural efficiency through adjusting the scale of farmland consolidation and accumulation, and the utilization of existing trade agreements.

The Korean frameworks, on the other hand, propose to further support international operations of domestic companies through improving quality assurance processes of domestic exports, and to secure competitiveness on the financial market by driving forward international efforts regarding the safe use of cryptographic assets.

5.4 Demand-Side

5.4.1 Public Procurement and Public Services

Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets

While the Japanese frameworks have provided almost no suggestions concerning public procurement at all, besides briefly mentioning it as a means to support startups, the Korean frameworks have put forward various strategies regarding the public procurement of innovative products and services, including implementing pilot projects, creating public markets, expanding the access to the public procurement market, increasing priority purchases of FIR products, and providing prototype procurement certifications and exclusive use cases for certain technologies. It has further been suggested to introduce a bidder selection model that puts a higher priority on innovativity, to include the utilization of FIR technology as an evaluation factor for local governments, and to assign preference to startups when conducting delivery performance evaluations. Moreover, the Korean strategies urge to be cautious not to unduly distort market mechanisms or to reduce fairness when initiating public procurement or initial market creation processes.

Public services through acquiring / maintaining / managing / innovating areas such as telecommunications / transport / construction / health services / public building

As far as the provision of public services goes, the Japanese frameworks focus on the areas of disaster and biological threat prevention, digital government, as well as on communication

networks as service fields that are to be innovated, while also briefly mentioning a few other areas, such as renewable energy and cyber security. The technology fields encompassed by those service areas include advanced information processing, data platforms and information processing systems, new personal identification approaches, AI, the 5G and optical fiber networks, high-performance computing, sensors, and robotics.

The Korean frameworks heavily focus this policy instrument as a means of driving forward the FIR, mentioning numerous public services through which the adaptation of new technologies by the private sector is to be facilitated, such as smart mobility, communication infrastructure, smart healthcare, smart public safety systems, intelligent environmental protection, or integrated public administration. The technology areas promoted include smart home technology, cooperative intelligent transportation solutions, real-time patient monitoring, intelligent surveillance, AI and big data-based environmental impact assessment, or smart grid, just to highlight a few of them.

5.4.2 User Involvement in the Innovation Process

Enabling involvement of relevant actors, organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, interlinking with emerging markets, lead users, crowdsourcing activities

To enable co-creation of knowledge and to ensure safe and sustainable consumption, the frameworks of both Japan and Korea promote citizen participation and the involvement of consumers in the innovation process through measures such as gathering public opinions, public dialogue, citizen science research, or through appointing technology communicators. Such strategies aim to include individuals in policy processes, to strengthen technology communication, to support collaboration between consumers and the private and public sectors, to allow for personalized consumption, as well as to enable individuals to act as prosumers.

The Korean strategies further suggest supporting the adjustment of rules and standards through fostering public debate, mentioning areas such as ethical issues regarding FIR technology, personal information protection, or the human responsibility with respect to intelligent technologies as fields in which public input is to be leveraged. In addition, the Korean frameworks promote including consumers in the technology planning process based on a public design approach, utilizing technology innovation methods that are based on user-participation, such as living labs.

5.5 Summary: Analysis

The following table provides an overview on the findings of this chapter. The two columns on the left indicate, for Japan and Korea individually, whether the respective policy instrument has been utilized or not. If at latest one of the outlined policy approaches has been identified within the analyzed frameworks, along with a concrete strategy as of how to realize them, the policy instrument is being counted as "applied" and marked with an "○" in the table. On the contrary, if no relevant policy approach could be identified, the policy instrument counts as "not applied", which is indicated by an "×" in the table.

Policy area	Policy strategy	**Policy instruments**	**Japan**	**Korea**
Knowledge creation, information diffusion, and skills	*Creation of knowledge and public R&D*	Direct funding, competitive research funding, block grants	◯	×
		Adjustment of research governance & scientific education, statutory regulations of research institutions	◯	◯
		Provision of physical research infrastructure	◯	×
		Promoting multi- & interdisciplinarity, promoting international cooperation	◯	×
	Information diffusion and technology adoption	Capacity building, promoting technology improvement, provision of access to testing facilities, incubation activities, provision of technology expertise & consultancy services, enable commercialization of innovation through technical & financial support, awareness-raising	◯	◯
		Improve accessibility of scientific data through open science, generate spillovers, interlinking of different research fields	◯	◯
		Provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations	◯	◯
		Management contracts between private & public organizations, public-private partnership	◯	◯
		Establishment of technology transfer alliances between research organizations, provision of knowledge networks & knowledge markets	×	◯
	Human capital and skill development	Regulation / organization / funding of national education system	◯	◯
		Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing	×	◯
		Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators	◯	×
		Focusing broader humanitarian education / multi- & interdisciplinarity / lifelong learning / technical literacy	◯	◯
		Preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation	◯	◯
		Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility	◯	×
		Strengthening support for external competence building, enable HR development through university-industry relations	◯	◯

Regulatory framework and business environment	*Financial incentives to enterprises*	Direct stimulants in the form of economic subsidies & investment, improving capital fluidity	◯	◯
		Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding	×	◯
		Indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings	◯	◯
		Tax benefits & relief aimed at supporting R&D activities such as tax reductions / tax exemptions / tax incentives / tax credits	◯	◯
	Competition, intellectual property, and standards	Antitrust policies targeting cartelization / vertical restrictions / merger regulation, interconnecting new enterprises with persistent monopoly	◯	◯
		Regulating intellectual property through patent law / regulating knowledge transaction / knowledge rights / regulating knowledge co-creation / taxation schemes incentivizing intellectual property assets	◯	◯
		Imposing technical standards, altering health / safety / environmental regulations	◯	◯
		Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms	◯	×
		Improving international competitiveness through adjusting tariff & non-tariff barriers / export restrictions / trade agreements / currency regulations, prevention of international exploitation	◯	◯
Demand-side	*Public procurement and public services*	Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets	×	◯
		Public services through acquiring / maintaining / managing / innovating areas such as telecommunications / transport / construction / health services / public building	◯	◯
	User involvement in the innovation process	Enabling involvement of relevant actors, organized discourse, definition of quality requirements from the demand-side, support of complementary technology, establishment of competitiveness centers, interlinking with emerging markets, lead users, crowdsourcing activities	◯	◯

Table 2: Analysis Results

6. Findings & Discussion

6.1 Similarities and Differences

Looking at the above table, it becomes clear that a large part of the possible policy instruments is utilized by both countries: Out of 28 possible instruments, 24 are promoted by the Japanese frameworks, while the Korean frameworks promote 22 of them. However, there is not a single policy instrument that is currently not being utilized by both the countries' policy frameworks, and some policy strategies in which there is a clear divergence among the countries' strategies have become apparent.

The only *policy strategy* field in which the approaches of both countries completely correspond is *user involvement in the innovation process*. Both Japan and Korea suggest utilizing the one possible policy instrument provided in this bracket, which concerns user and consumer involvement in the innovation process.

The policy strategies that are largely treated similarly are *information diffusion and technology adoption*, *financial incentives to enterprises*, and *competition, intellectual property, and standards*. In these three brackets, all policy instruments are utilized, except for the following: As far as information diffusion and technology adoption go, Korea utilizes all possible instruments, whereas no policy approaches regarding the establishment of technology transfer alliances or the provision of knowledge networks and knowledge markets could be identified in the case of Japan. Moreover, regarding the provision of financial incentives to the private sector, no policy approaches as to how to directly support enterprises by means of asset financing in the form of measures such as loans or credits are proposed by the Japanese frameworks. On the other hand, the Korean strategies provide no concrete input concerning the implementation of soft instruments, such as voluntary standards or norms, in order to further regulate competition, intellectual property, and standards.

A larger divergence can be noticed in the case of the policy strategy *human capital and skill development*. While, in this field, most instruments could be identified as being utilized by both countries' frameworks, the Japanese frameworks propose no policy approaches regarding the incentivization of vocational training, learning by doing, apprenticeships, or on-the-job training. Within the approaches provided by the Korean strategies in this bracket, in contrast, neither the fostering of entrepreneurship, problem-solving skills, communication skills, or the provision of business accelerators is promoted nor are the adjustment of migration regulation and access

to the domestic labor market or the issue of reverse brain drain and enhancing global mobility specifically addressed.

The differences between the two country cases' FIR approaches concerning the policy strategy field *public procurement and public services* are somewhat more substantial, especially considering that this category consists of only two possible policy instruments. While the Korean frameworks promote both possible instruments, the Japanese strategies only focus on public service provision in this bracket, meaning that no suggestions are made with regard to public procurement or the establishment of public markets as measures to create demand for innovation by the Japanese frameworks.

The most significant disparity between Japan's and Korea's policy approaches was identified within the policy strategy *creation of knowledge and public R&D*: In this category, the Japanese frameworks promote all policy instruments, whereas within the Korean frameworks, only one out of the four possible instruments could be identified. While Korean strategies do promote the adaptation of research governance and the adjustments concerning the regulation of public research institutions, no concrete policy approaches regarding direct funding, the provision of physical research infrastructure, or the promotion of multi- and interdisciplinarity and international cooperation are suggested.

Lastly, looking at the summarized results on the more general level of *policy areas*, the following observations can be made: The highest degree of similarity is prevalent in the area *regulatory framework and business environment*, within which both Japan and Korea respectively utilize eight out of nine possible policy instruments. In the area *knowledge creation, information diffusion, and skills*, the divergence is slightly larger, with Japan using fourteen and Korea using eleven out of the sixteen possible instruments. The largest difference on this level, in terms of used to not-used ratio, can be observed in the *demand-side* policy area, since Japan utilizes only two out of three instruments herein, while Korea makes use of all of them.

The following list highlights all areas in which the policy suggestions made by the two countries' frameworks differ from each other. On the left, all policy instruments identified as being utilized only by the Japanese strategies are listed, while on the right-hand side, those promoted solely by the Korean frameworks are displayed:

Japan only	Korea only
Direct funding, competitive research funding, block grants Provision of physical research infrastructure Promoting multi- & interdisciplinarity, promoting international cooperation Fostering entrepreneurship / communication skills / problem-solving skills, provision of business accelerators Adjusting migration regulation, facilitating foreign workers' access to domestic labor market, addressing reverse brain drain, enhancing global mobility Soft instruments such as CoCs / voluntary technical standards / shaping cultural & social norms	Establishment of technology transfer alliances between re-search organizations, provision of knowledge networks & knowledge markets Incentivizing vocational training / on-the-job training / apprenticeships / learning by doing Asset financing & debt and equity financing through loans / loan guarantees / credit loans / credit guarantees / advances / research grants / equity investment / risk capital / risk-sharing / mezzanine funding Public procurement through R&D contracts / government contracts & purchases / prototype purchasing, establishing public markets

Table 3: Differing Policy Tools

6.2 Differing Innovation Performance

When looking at the similarities and differences identified above, it is important to keep in mind that they merely reflect focus areas of the respective countries' current FIR innovation policy strategies. Being classified as "not utilized" within the analyzed frameworks does not necessarily mean that measures in these areas are not applied by the countries' governments at all. For example, Korean universities do in fact demonstrate a strong commitment to multi- and interdisciplinarity, which is reflected in projects such as the Korea University's School of Interdisciplinary Studies (Korea University 2020), Seoul National University's broad offering of interdisciplinary programs (Seoul National University 2020), Hanyang University's secondary field approach (Hanyang University 2021), or the Korea Advanced Institute of Science and Technology's KAIST Institutes, which focus on interdisciplinary research (KAIST Institutes 2020). Another example would be the public procurement system in Japan, which is, although not being promoted in the country's FIR policy strategies, of course existent and subject of ongoing government efforts (CAO 2019), and support systems, such as an online procurement portal (Ministry of Internal Affairs and Communications 2021), are indeed in place.

However, it is likely that influencing factors for differences in innovation performance are to be found among the areas identified as divergent between the two countries. Thus, when looking at them in the context of relative innovation performance, the conclusion should not be to think that a policy approach has no validity if it is not utilized by a country with a higher

degree of innovation performance, or that innovation performance can be increased by simply adopting a policy approach promoted by a higher-ranking country. The results provided by the analysis should much rather provide an insight into the areas in which policy can be designed differently and into what those differences might entail. To put it bluntly, for the cases analyzed in this paper, the lesson to be learned for Japan is not to simply do less public R&D and to increase demand creation efforts in order to increase overall innovation performance. The deduction should rather be to rethink the approaches currently chosen in the respective policy fields by understanding how things are done differently elsewhere and to assess if one's own policy strategy could potentially be adjusted in a manner similar to that promoted by the higher-ranking country's frameworks.

I am going to try to further illustrate this notion by using the previously mentioned example of multi- and interdisciplinary research and education: Rather than presuming that this policy instrument is not promoted in Korea's FIR frameworks because interdisciplinarity is not valued by the academic system and by policymakers, one could also assume that there is no necessity to specifically promote its improvement due to it already being in a good place as well as being promoted through other channels. Therefore, the insight gained should not be to simply abandon current measures furthering interdisciplinarity in science, but that by taking a closer look at how Korea overall handles multi- and interdisciplinarity, new understanding is likely to be gained as to how the Japanese university system can be adjusted in order to drive forward multi- and interdisciplinarity efforts. Similarly, looking at the example of policy approaches regarding public procurement, the lack of policy proposals provided by the Japanese frameworks does not indicate that public procurement has so far not been seen as a valid approach towards furthering the innovation process, and that the measures proposed by the Korean frameworks should be directly adopted. It should rather be understood as an indication to further look into expediting current procurement efforts and designing future policy strategy in the field, possibly taking procurement strategies proposed by the Korean frameworks into account.

6.3 Similar but Different

In addition to the above, I have discovered a number of other levels of similarity and difference which the framework does not directly reflect. More specifically, I am referring to policy instruments that have, in the context of the framework, been identified as being utilized by both countries. However, in the course of the analysis, some of them have exhibited a convergence in the approaches chosen by Japan and Korea on a more subtle level. The first example of such

a dissimilarity are cases in which different aspects of the same policy instrument have been used. An instance for this can be found within the policy instrument *preventing skill bottlenecks, improving career development opportunities & monetary rewards, adjusting employment regulations for researchers, matching workers & jobs more efficiently, improving recruitment & training of researchers, removing access barriers, improve women's participation*: While both countries' frameworks promote improving working conditions for researchers, flexibility of workstyles, and HR mobility, the Korean frameworks additionally strongly emphasize issues regarding employment stability and social security, while bolstering women's participation in the labor market is only explicitly promoted by the Japanese strategies.

Secondly, in some cases, although the same aspects of the policy instrument are promoted, the specific approaches towards realizing them differ from each other, such as in the case of the bracket *strengthening support for external competence building, enable HR development through university-industry relations*: Here, the Korean strategies focus on external education carried out by universities, on-site training, and providing incentives for participating in external education activities. The Japanese frameworks, on the contrary, promote personnel exchange between academia and industry, improvement of recruitment measures through university-industry collaboration, and increasing the participation of external lecturers in high school education.

The third level of disparity revolves around the volume and diversity of contributions to a specific policy instrument. The bracket *imposing technical standards, altering health / safety / environmental regulations* constitutes an example in which levels of volume differ between the country cases: Both Japan's and Korea's frameworks suggest similar approaches towards addressing the adjustment of current regulations and standards. However, while Japanese strategies focus solely on personal data protection and furthering decarbonization, the Korean strategies propose a large number of intervention areas and a wide variety of intervention measures. An example regarding a differing diversity of contributions can be found in the policy instrument *provision of networks & infrastructure for collaborative research, innovation centers & centers of excellence, facilitating spin-offs, establishing transnational agreements & organizations*: While only one of the three Japanese policy frameworks analyzed in this paper makes suggestions in regard to this policy instrument, three out of the four Korean strategies issue proposals on how to address this field.

Lastly, the analytical framework in its current state does not differentiate between strategies that aim to promote change within the institutional context and such that aim to change the

institutional context itself, which has been pointed out as a crucial distinction among innovation policy approaches (Lundvall & Borrás 2005, 612-3). The policy instrument *indirect support through facilitating access to venture capital / seed capital / early-stage financing / business angels / government-backed venture capital, supporting public SME listings* serves as an example for such a difference: In this bracket, the Japanese frameworks propose measures concerning the formation of a public venture fund and information provision on FDI opportunities, therewith promoting change within the given institutional context. Korean strategies, on the other hand, aim to adjust the institutional context through measures such as the revision of investment regulations, easing funding restrictions, as well as facilitating access to public SME listings.

6.4 Summary: Findings & Discussion

Consolidating the above findings, I am going to conclude this chapter by circling back to the research question proposed at the beginning of this paper. To reiterate, the research question is as follows:

What are the similarities and differences of Japan's and South Korea's public policy approaches towards strengthening innovation processes aiming at furthering the Fourth Industrial Revolution, and how can the countries' choice of policy instruments explain their difference in innovation performance?

Areas in which the analyzed FIR innovation policy frameworks have displayed a high level of similarity, with only marginal divergences between the countries' approaches, are those concerning user involvement in the innovation process, information diffusion, financial incentives, as well as competition and standards. As far as the development of HR and the fostering of skills go, a larger difference between the country cases' strategies has been identified, with Japan not promoting any concrete measures in areas such as vocational training or learning by doing, and Korea not proposing tangible strategies regarding the fostering of entrepreneurship as well as the enhancement of foreign HR acquisition and global mobility. The most substantial differences could be observed in the areas of public procurement and public services as well as creation of knowledge and public R&D: While the Korean frameworks promote measures aiming at furthering innovation by providing both public services and public procurement, the Japanese strategies solely focus on public service provision in this bracket, not providing any concrete courses of action with regard to public procurement. On the contrary, while the Japanese frameworks promote all possible policy instruments regarding the support of public R&D and

knowledge creation, the Korean strategies only promote adjusting regulation and governance of research and scientific education, not proposing any concrete actions regarding the funding of public research, the provision of physical research infrastructure, as well as the fostering of multi- and interdisciplinarity and international research cooperation. Overall, out of the 28 possible policy instruments included in the analytical framework, a total of 10 instruments has only been chosen by one out of the two countries, and there is no instrument which is not applied at all by either of the country cases' frameworks. This means that FIR innovation policy approaches diverge from each other in over a third of all possible fields.

Concerning the question as to how the chosen policy approaches explain the country cases' difference in innovation performance, the results of the analysis provide reference points indicating the likely areas responsible for differing performance by highlighting policy areas in which the countries' innovation strategies deviate from each other. Keeping in mind that the fact that a policy measure is not promoted within the analyzed frameworks does not mean that it is not utilized by the respective country at all, a policy tool applied within the analyzed strategies is not automatically to be abandoned by a lower performing country just because a country with a relatively high performance rating is not currently promoting it. Vice versa, just because it is utilized by a country with higher innovation performance, a policy tool does not necessarily need to be directly adopted in order to improve one's own performance. The insight gained by comparing the different FIR policy approaches much rather provides an understanding of how policy design can be approached differently. Thus, although it can be said that the analysis cannot definitely explain which exact policy choices are responsible for differing levels of innovation performance between the assessed country cases, it does highlight the areas likely responsible for differing levels of innovation performance, namely those in which one country applies concrete policy instruments and the other one does not.

In the course of the analysis, I have also discovered that while, according to the analytical framework, some policy tools are applied by both countries, the country cases' approaches towards that same policy tool might actually differ on a less palpable level. Examples for such subtle differences are cases in which different policy approaches are chosen from within the same policy tool category or such in which the precise measures suggested to apply the same policy instrument differ between the analyzed country cases. The factor of differing volume and diversity of policy suggestions provided by the countries' innovation strategies towards single policy tool brackets also needs to be taken into consideration, as it might indicate diverging levels of priority. In addition, the analytical framework in its current state does not

differentiate between policy strategies that aim at changing the institutional context itself and such that promote change within the existing institutional context. While these aspects have not been directly taken into account by the analytical framework utilized in this thesis, their implementation into future research approaches might assist in developing a deeper understanding of the similarities and differences between national FIR innovation policy approaches and, ultimately, might help to comprehend how those differences influence innovation performance.

7. Conclusion & Outlook

In the light of the increasing gap in innovation performance between Japan and Korea as well as the ever-growing importance of FIR technologies to drive forward innovation, this thesis has set out to investigate the similarities and differences between the countries' FIR innovation policy approaches. I have argued that, due to the lack of a notion of optimality, a direct comparison between two country cases is more practical than comparing them to an ideal system, and that, despite an increasing level of internationality in innovation efforts, an analysis on a national level is relevant due to the fact that innovation policies are to a large part shaped by national legislations, institutional setups, and economic conditions. Comparability of the chosen country cases is argued to be given due to their similarities in industrial focus, political homogeneity and centralization, and their shared emphasis on utilizing FIR-specific innovation strategies.

Laying the basis for the analytical approach applied in this thesis, the current state of the art has been presented in the form of a literature review which covers the provenance of innovation systems and innovation policy research, elaborates on the concept of systems of innovation, and discusses scholarly cross-country innovation policy analyses as well as scientific contributions analyzing FIR innovation policy. Based on the findings of the state of the art chapter and concerning the notion of national innovation systems, an analytical framework incorporating a total of 28 possible policy instruments has been devised. Encompassing the areas of knowledge creation, information diffusion, fostering of skills, regulatory framework, business environment, and demand-side measures, this conceptual framework was designed to cover all possible areas of innovation policy intervention.

The results of the analysis have shown that although the Japanese and Korean approaches are widely similar across most policy areas, they significantly differ from each other in some distinct fields. Intervention areas in which innovation policy suggestions have been identified as largely similar are those aiming at facilitating the diffusion of information and adoption of technology, the provision of financial incentives to private businesses, the adjustment of standards and competition regulation, and the involvement of users in the innovation process. A slightly higher degree of divergence between the countries' strategies was found in the field of human capital and HR skill development. The largest differences were identified in the areas of knowledge creation and public R&D as well as public procurement and public services. Overall, the analysis' results show that while every possible policy instrument is promoted by

at least one of the two country cases' FIR innovation strategies, more than a third of all policy instruments is applied by only one of the two.

As far as the influence of those differences on the countries' respective innovation performances goes, I have argued that the causes for diverging levels of performance are likely to be found within the policy areas that are promoted by only one of the two countries' frameworks. As the results only show the measures proposed specifically within Japan's and Korea's FIR innovation strategies rather than the countries' entire institutional and regulatory compositions, not being identified as promoted in the course of this analysis does not necessarily mean that a certain policy instrument is not utilized by the country in question at all. Therefore, these results should not be understood as a list of policy approaches that either improve or impair national innovation performance but as indicators specifying the areas in which the causes for differing levels of innovation performance between the country cases of Japan and Korea are likely to be found and as reference points on how policies can be designed differently.

The analytical framework utilized in this thesis determines differences and similarities of certain policy tools based on whether they are promoted by the countries' policy strategies or not. During the analysis, it has, however, become apparent that there are more subtle levels on which seemingly similar policy approaches can differ from each other. Such dissimilarities are caused by similar policy tools being grouped in the same category of the analytical framework, by differences in policy execution, and by a diverging volume and diversity of contributions. Additionally, the question whether certain strategies promote change within the institutional framework or suggest changing the institutional framework itself has, in the course of this thesis, not been taken in consideration. For future research, the analytical framework (or single parts of it) could be improved by further diversifying the number and detail of policy instruments and by implementing assessment criteria that indicate levels of volume and numbers of contributing policy sources. Also, in order to achieve a more comprehensive understanding of the intricacies of certain policy measures and whether they are aiming at changing the institutional setup or not, a more detailed comparison between single policy tools could be introduced. Taking all those less discernible levels of dissimilarity into account for continuing research will certainly help to further widen our understanding as to how different policy approaches influence FIR innovation performance.

In addition to expanding the analytical methodology itself, the scope of comparative research in the field of FIR innovation policy can be further widened by increasing the number of country cases incorporated into the analysis. By including additional FIR policy frameworks

surrounding initiatives such as the German and Austrian *Plattform Industrie 4.0* or the Chinese *Made in China 2025* in the comparison, further insights are to be gained concerning the similarities and differences of national FIR innovation approaches and how variations in national innovation performance can be explained on the policy level.

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Appendix

Abstract (English)

In the light of a widening gap in innovation performance between Japan and South Korea and considering the importance of strategies and technologies related to the Fourth Industrial Revolution (FIR) as drivers of innovation, this thesis aims to analyze the similarities and differences of the two countries' current innovation policy strategies directed at furthering the FIR. The objective is to enable the evaluation of policy regimes currently in place by allowing for a direct comparison of the policy mixes proposed by the country cases, as well as to shed some light on how variations in policy strategy can explain differing levels of national innovation performance. Based on a review of the current literature on innovation policy analysis, I propose a methodological framework surrounding the notion of national systems of innovation, encompassing a comprehensive catalogue of 28 policy instruments covering all fields of possible public policy intervention. After examining the country cases' current policy strategies in accordance with the methodological framework, the policy approaches put forward by Japan and South Korea are evaluated and compared, and I determine whether the utilization of each individual policy instrument is suggested or not. The results show that, although the countries' strategies widely concur across a large part of policy areas, substantial differences can be found in the fields of public knowledge creation and R&D as well as with regard to public procurement and public services. Overall, I identify six policy instruments as solely being used by Japan, whereas four are promoted by the South Korean strategies only. I argue that the causes for divergence in innovation performance are to be found within those differing policy instruments. However, since factors aside from the analyzed FIR innovation policy strategies also influence how countries fare in fields such as knowledge creation or public procurement, the higher-ranking country's approach identified in this study cannot be considered as being categorically more effective in improving innovation performance. The policy fields in which differences have been identified should instead be regarded as areas in which adjustments can lead to change in innovation performance. Moreover, the analysis has also shown that for some cases in which the proposed measures are seemingly similar, dissimilarities can exist on a more subtle level, such as differing policy execution approaches. The findings indicate that South Korea's FIR innovation policies are not simply to be adopted by Japan in order to increase innovation performance. Rather, the policy areas in which differences have become apparent should be further investigated, and a reevaluation of current policy strategies in those fields should be considered.

Abstract (German)

In Anbetracht des wachsenden Gefälles zwischen Japans und Südkoreas Innovationsleistung, und angesichts der Wichtigkeit von Strategien und Technologien im Zusammenhang mit der Vierten Industriellen Revolution (VIR) als Innovationstreiber, werden im Zuge dieser Arbeit die Ähnlichkeiten und Unterschiede zwischen den staatlichen Innovationsstrategien zur Förderung der VIR der beiden Ländern untersucht. Ziel der Studie ist es, durch den direkten Vergleich der Länderfallstudien die jeweiligen Strategien zu analysieren, und der Frage nachzugehen, wie strategische Unterschiede ungleiche Niveaus von nationaler Innovationsleistung erklären können. Basierend auf einer systematischen Literaturanalyse der wissenschaftlichen Beiträge zur Untersuchung von staatlichen Innovationsstrategien wird ein analytischer Ansatz vorgestellt, welcher, in Form eines umfassenden Kataloges über 28 strategische Instrumente, alle Bereiche möglicher öffentlicher Intervention abdeckt. Nach Untersuchung der aktuellen Strategien der Länderfallstudien gemäß der vorgebrachten Methode werden Japans und Südkoreas strategische Ansätze bewertet und verglichen, und es wird festgestellt, ob die einzelnen strategischen Instrumente Anwendung finden oder nicht. Die Ergebnisse zeigen, dass die Strategien der beiden Länder zwar in den meisten Bereichen weitgehend übereinstimmen, deutliche Unterschiede bestehen jedoch in den strategischen Feldern der öffentlichen Wissensbildung und Forschung und Entwicklung, sowie des öffentlichen Beschaffungswesens und der öffentlichen Dienstleistungen. Insgesamt konnte ich feststellen, dass sechs Strategien ausschließlich von Japan verwendet werden, während vier nur von südkoreanischer Seite vorgebracht werden, was mich zu der Annahme bringt, dass die Ursachen für die unterschiedliche Innovationsleistung in diesen voneinander abweichenden strategischen Instrumenten zu finden seien. Da jedoch auch andere Faktoren neben den untersuchten VIR Strategien die Situation der Länder in diesen Bereichen beeinflussen, sollte der strategische Ansatz des höherrangigen Landes nicht grundsätzlich als wirksamer betrachtet werden. Vielmehr sollten die Bereiche, in denen Unterschiede bestehen, als Gebiete verstanden werden, in denen strategische Anpassungen zu Veränderungen der Innovationsleistung führen können. Die Analyse hat darüber hinaus auch gezeigt, dass innerhalb scheinbar ähnlicher strategischer Ansätze Unterschiede auf differenzierterer Ebene bestehen können, so wie etwa die konkreten Herangehensweisen zur Umsetzung der Strategien. Die Erkenntnisse deuten darauf hin, dass Japans Innovationsleistung nicht einfach dadurch gesteigert werden kann, indem südkoreanische Strategien übernommen werden. Die Bereiche, in denen Unterschiede erkennbar geworden sind, sollten vielmehr weiter untersucht werden und eine Neuausrichtung der aktuellen Strategien in diesen Feldern sollte in Betracht gezogen werden.