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Public Sector Innovation: Organizational and Institutional Trends in the Post-New Public Management Era

Change Agents in Modern East Asian Innovation Bureaucracies

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Abstract

In this paper we are interested in how the processes of justifying, drafting and implementing societal challenges oriented STI policies are co-evolving in two East Asian economies – Japan and Taiwan – given their specific politico-economic legacies and contexts. We identify three key challenges regarding the design of such STI policies and use these as an analytical framework for our analysis. We show that especially since the GFC, both Japanese and Taiwanese national strategies have introduced STI policy justifications and directions based on the definition of specific societal challenges/needs. Yet, these justifications are not fully accepted by all politico-administrative actors and have been brought to the arena during specific chance events or windows of opportunities. As a result, and as opposed to Western trends, the institutional designs to implement the new policy directions seem to lead towards further centralization of key STI policy functions. While we see rather similar developments to global trends on the level of policy ideas/rhetoric and the design of specific instruments, an alternative form of governance seems to be emerging in East Asia that is influenced by the politico-administrative elite centred legacies of 'developmentalist' policy-making.

Keywords: innovation policy, public management, change agents, East Asia

1. Introduction

Especially since the 2008 Global Financial Crisis (GFC), 'grand' and 'societal' challenges have taken a central stage in both policy and academic debates on how to pursue science, technology and innovation (STI), what is the appropriate role for the state and public policies and how tackling these challenges could become integral part of general economic development strategies (see Fagerberg et al. 2013; Hicks 2016; Mazzucato 2013; 2016; Ulnicane 2016). As these concepts have been introduced to the policy arena only recently and through fragmented initiatives of single individuals (globally recognized scholars, business leaders) and public and private organizations (see Hicks 2016) with their own agendas, the exact framing and institutionalization of these concepts is only emerging. In related policy debates, there have been arguments that classic Apollo and Manhattan type 'mission oriented' STI programs, or even 'new deals', are needed for tackling complex challenges in the areas from health and social welfare to low-carbon energy transitions and environmental sustainability. Yet, it has been also recognised that modern challenges may be fundamentally different from post-WWII public sector driven missions. Modern challenges are considered to be explicitly 'boundary-spanning' as they tackle interdisciplinary real-life problems that require international, cross-organizational and cross-sectoral (public-private) collaboration in STI funding, development and diffusion. (Arundel et al. 2011; Foray et al. 2012; Mowery et al. 2010; Ulnicane 2016) Thus, they may also require new STI policy logics and governance arrangements.

Some STI scholars argue that it may be insufficient to rely on classic market and system failures based policies, institutions and instruments. Solutions to many societal challenges require triggering and diffusing innovations in so called 'legacy sectors' with established paradigms and entrenched interests regarding production, consumption, regulation, governance (Bonvillan and Weiss 2015). As a result, STI scholars are developing new STI policy frameworks from 'transformative change' approach (Weber and Rohracher 2012) to 'entrepreneurial state' and revised versions of the 'developmental state' (Block 2008 Block and Keller 2011; Mazzucato 2013; 2016; Kim and Thurbon 2015). As policy analytical tools, these frameworks try to operationalize both *ideational* aspects (justification, legitimization of government role and policies) and *institutional* elements (policy and instrument design, implementation and feedback and evaluation systems) needed for effective functioning of new types of STI policies. There seems to be a growing consensus in the literature that modern challenges may require policy and governance approaches that balance between *direction giving* role of the state and maintenance of spaces for more *bottom-up and experimental search*. Further, *participatory feedback arenas* may be needed for defining and legitimizing specific challenges and missions. For actual policy implementation, *change agents* – organizations with dynamic capabilities – may be needed that develop, test and implement novel and often *experimental* policy instruments and mixes fit the boundary-spanning nature of the challenges.

Importantly, as concepts such as grand and societal challenges that are developed by STI elites, they tend to have global rhetorical appeal. Regardless of economic and political differences, countries from different regions tend to consciously benchmark each other in terms of the content and governance of STI policies. Though, most of the time the focus, rhetoric and content of policies seems to be more important and easily transferrable than systems of governance. This creates complex co-evolutionary but often punctuated interactions between local ideational and institutional legacies and new ideas and institutions introduced to these policy arenas (Karo and Kattel 2016a). For example, the South Korean 'green growth' initiative adopted much of the ideational and rhetorical toolbox of grand and societal challenges, but in its institutional approach, the 'green growth' policies have been arguably pursued through the logic of the East Asian 'developmentalism', or 'developmental environmentalism', that still prioritizes economic development concerns over other social goals and maintains state-centric approach to STI governance (see Kim and Thurbon 2015; Han 2015; Seong et al. 2016).

In this paper we are interested in how the processes of justifying (ideational approach), drafting and implementing (institutional designs) challenges oriented STI policies are co-evolving two East Asian economies – Japan and Taiwan – given their specific politico-economic legacies and contexts. For this analysis, we have worked through existing policy documents and secondary literature (policy strategies, organizational and policy reports, and academic research) and conducted interviews with local policy makers and experts to corroborate the facts and our interpretations of the co-evolution of policies and institutional designs.[1]

[1] We are in the process of carrying out expert interviews (in some cases informal discussions) with past and current policy makers and experts from key ministries and organization of Japanese and Taiwanese STI systems (ministries of economy, education and science, high-level coordination bodies).

In the next section we will provide a brief review of recent conceptual advances regarding the ideational and institutional approaches to societal challenges based STI policies. We identify three key challenges regarding the design of such STI policies and use these as an analytical framework for our empirical study. We show that especially since the GFC, both Japanese and Taiwanese national strategies have started to introduce STI policy justifications and priorities based on the definition of specific societal challenges/needs. By now, Japanese STI policies are being framed through the concept of *Society 5.0*, or super smart society, and Taiwanese STI policy documents have recently referred to the concept of *low-carbon intelligent society*. Both of these emergent concepts reflect the logic of prioritizing STI and supporting public and private STI activities in a way that balances between the goals of sustaining/increasing economic growth while also improvement of social and environmental living conditions of people. Yet, as opposed to Western approaches, the institutional designs to implement these ideas seem to lead, as also in the case of South Korea, towards further centralization of key STI policy functions (through strengthening the role of the Cabinet Office and its Council for Science, Technology and Innovation, CSTI, in Japan; creation of the Ministry of Science and Technology, MOST, and Board of Science and Technology, BOST, of the Executive Yuan in Taiwan). At the same time, the design of policy instruments seems to again be based on similar principles as in the West (especially US). Thus, while see rather similar developments on the level of policy ideas/rhetoric and instruments, an alternative form of governance seems to be emerging that is influenced by the politico-administrative elite centred legacies of 'developmentalist' policy-making. In the discussion, we summarize the main elements of this form of governance and discuss its potential strengths and limitations.

2. Ideational and institutional frameworks to tackle grand and societal challenges through STI polices

2.1. Key governance challenges

On the broadest level, STI policies focusing on societal challenges could be placed into the broader theoretical and conceptual frameworks of 'socio-technical transitions' (Geels and Schot 2007), or more specifically 'sustainability transitions' (Markard et al. 2012). These approaches seek to understand socio-technical transformations towards e.g. low-carbon energy systems through multi-level frameworks combining public, private and social activities on the levels of niches, regimes and socio-technical landscapes. The predominant stream of this research seems to recognize that neither evolutionary nor mission-oriented transitions can be managed through traditional command and control type mechanisms and institutions that are usually at the centre of public policy efforts. Rather, system coordination, or transition management, through open-ended and 'co-productive' networks and reflexive governance mechanisms may be more successful. (Loorbach and Rotmans 2006; Vos et al. 2009; Rogge and Reichardt 2016)

Yet, as argued by Angel and Rock (2009) such co-productive and bottom-up processes driven institutional frameworks may be context specific and suit a few Western Europe systems, if at all, while most other countries strive to tackle societal challenges by only gradually reforming their existing governance and policy approaches. Thus, some scholars – who follow the line of 'transition' research, but focus on socio-technical transformations and societal challenges strategically defined, prioritized and tackled by governments under – have tried to

complement market and system failures based 'structural' STI policies '*which focus on optimizing the structure of innovation systems and their ability to generate new knowledge and technology'* with '"*transformation-oriented innovation policies" which strategically focus on the transformation of whole systems of innovation, production and consumption'*, (Weber and Rohracher 2012: 1037-1038) through '*comprehensive system innovations, i.e. novel configurations of actors, institutions and practices*' (Ibid.: 1037). Thus, Weber and Roharcher (2012) have introduced the concept of *directionality failure* together with *demand articulation*, *policy coordination* and *reflexivity failures* to operationalize the specific conditions when the state can also play an explicit direction giving and coordinative role.

Mazzucato (2013; 2016; also Block and Keller 2011) has argued that broader application of the theory or concept of the 'entrepreneurial state' may be a feasible pathway for justifying and legitimizing policy priorities that focus on current economic and societal challenges. The entrepreneurial state approach seeks to develop justifications (mostly based on historical and comparative lessons) and governance frameworks for the role of the state in *creating* and *shaping* markets, or *giving direction* to predominantly market-forces driven STI developments. This focus makes the debates on modern societal challenges complementary to the debates on post-WWII mission-oriented policies (see Foray et al. 2012; Mowery et al. 2010) and the recent work on the challenges of innovation in the US 'legacy sectors' (Bonvillan and Weiss 2015). Mazzucato (2016) has argued that the direction giving approach to STI requires not only *ideational change*, but also development novel *organizational and policy capacities* (for experimentation, learning, self-discovery), *dynamic evaluation frameworks* and *symbiotic public-private partnerships*.

There seem to be at least three key governance challenges regarding the design and implementation of challenge/mission oriented policies:

1. How to define and legitimize specific challenges that would incentivize different public sector organizations and also academic and private actors to work towards shared goals?
2. How to implement challenge oriented policies and maintain a sustainable balance between direction giving role of the state and spaces for more bottom-up and experimental search?
3. How to create dynamic feedback arenas and evaluation practices to sustain the evolutionary, dynamic and boundary-crossing nature of search processes of tackling societal challenges?

Regarding the *first* challenge, there seems to be a common understanding that STI policy logics or justification may have to go beyond traditional market or system failures driven STI policy rationales that focus on improving general framework condition for firm- and industry-level search and selection processes. While exact terminology of challenges, mission, directions, priorities etc is not yet systemized, according to Mazzucato and Penna (2016: 100-101), ability to set exact focuses for STI policy efforts matters greatly for conceptualizing the exact role of different actors and defining appropriate governance mechanisms:

> Missions are not the same as societal challenges; missions define ways to address a societal challenge and require many different sectors to interact in new ways. Indeed,

more granular definition of *technological* missions to address the societal challenge, for instance, facilitate the establishment of intermediate goals and deliverables, and processes of monitoring and accountability. When a mission is too broadly defined and represents the societal challenge at large, governance can become faulty, and there is a risk of being captured by vested interests that are able to 'bend' the mission in their favor.

Well defined challenges/missions should ideally help to improve the prioritization of STI policies as well as nudge private actors towards search and self-discovery in complex and uncertain areas into which private actors alone would not be willing to enter and invest. One of the crucial debates between different strands of thinking focuses on how such definitions and consensuses should be achieved. Given the boundary-spanning nature of modern challenges and need for broader diffusion of STI outputs for actual transformative impacts, some advocate for *participatory governance* mechanisms to create shared and collective visions and consensus. Others seem to agree that such visions would emerge through less collective and more conflictual and contested processes. (For overview of debates, see Weber and Rohracher 2012: 1040-1041) Thus, the state could trigger and coordinate such collective actions through its visionary goal setting and demand articulation either by politico-administrative or broader elites (including also business and academia).

Regarding the *second* challenge, different approaches seem to also agree that traditional top-down and stability oriented bureaucracies need to develop more *dynamic capabilities* for learning, experimentation. It may be rather difficult to maintain such capabilities in single organizations or organizations based on similar routines (Karo and Kattel 2016a). Thus, different challenge and mission oriented approaches seem to highlight the critical role of *change agents* tasked with developing and implementing novel and often experimental organizational solutions and policy instruments and policy mixes. Existing research of Western experiences regarding such experimentation and policy innovation has proposed different types of change agents: *charismatic policy entrepreneurs* (Link and Link 2015), *small peripheral and flexible agencies* that are insulated from both political interests and resources (Breznitz and Ornston 2013); *mission-oriented*, flexible *and politically well-connected to and protected* agencies, such as DARPA (Bonvillian and Weiss 2015). The task of these agencies is to trigger (technological, political, policy or other) changes by developing, experimenting with and/or demonstrating novel solutions. Given the complexities of boundary-crossing and STI related challenges, they should at the same time be both change- and mission-oriented (as opposed to generic change agencies), i.e. focusing on triggering changes in specific complex field where unique capabilities are needed.

Regarding the *third challenge,* there seem to be common arguments that next to more *participatory governance and feedback arenas* (that could be either key avenues for common vision setting, definition of challenges etc, or complementary legitimation tools), also policy evaluation systems should become less principal-agent type (*ex ante* formulation of performance goals). Instead, evaluation practices should follow principles similar to the logic of 'experimental governance' (common visions to be adopted and adjusted by different stakeholders and subsequently evaluated through open-ended peer-review like approaches focusing both on processes and outcomes; e.g. Sabel and Zeitlin 2010), or mimic high-risk approaches found in the private sector, such as 'portfolio approach' (Mazzucato 2016).

2.2. Contextual differences

It is fairly obvious that the politico-economic and politico-administrative differences and legacies will influence the overall applicability and ease of developing such solutions to these governance challenges. It is likely that while there are globally emerging common narratives and consensuses regarding some aspects of societal challenges, actual policy approaches and institutional designs remain more distinct as domestic political, policy and administrative legacies continue to influence policy making processes (Karo and Kattel 2016a).

For example, the US-based STI policy debates have been for a long time stuck in the ideological state-market confrontation. This has led to the emergence of the 'hidden' decentralized and networks developmental state (Block 2008; Block and Keller 2011). Yet such approach may not suffice for innovations in more complex and entrenched legacy sectors (Bonvillan and Weiss 2015) and for tackling boundary-spanning challenges (Hicks 2016). While Obama administration placed grand and societal challenges as one of the core pillars of US STI policies already in late 2000s and tried to pursue these through existing governance design, it has recently also proposed to develop new policy toolkits for public sector innovation and more bottom-up and participatory approaches to find other pathways for legitimizing policies and for co-producing and diffusing solutions to challenges (innovation labs, social innovation etc) (see NEC and OSTP 2015). The EU's STI program Horizon 2020 has taken societal challenges as one of its core priorities and has defined these challenges in rather open ended way. Thus, it relies on relies on expert based consultations to define annual projects and ideas to be implemented. Yet, the evaluation metrics seem to still focus on indicators inherited from the linear and supply-focused STI policy era (publications, patents) (Ulnicane 2016).

Based on the broad mapping of challenge-oriented policy initiatives (in climate change and energy, and healthy aging related challenges and strategies), Leijten et al. (2012: 7) distinguish three broad policy strategies towards tackling societal challenges:

- *Policy mainstreaming:* 'trying to build the grand challenge into regular policy making and implementation is a tendency which can be found almost everywhere';
- *Jumping to science and/or technology:* 'where in Europe the challenge is translated into a jump to (fundamental) scientific challenges, we find in the USA a stronger focus on jumping to technologies and creating longer term industrial opportunities';
- *Comprehensive transition approach:* 'building on a strong tradition of national priority setting, several Asian countries succeed in taking a comprehensive approach in which scientific research, technology development, industrial innovation and social organisation are being aligned for a systemic transition towards green growth, green industry and green employment'.[2]

While Leijten et al. (2012) link these strategies with *national* approaches, we can conjecture that differences in the introduction (by whom and when) and operationalization of grand and societal challenges may also differ within countries across different STI policy *organizations*.

[2] Though, this assumption that East Asian economies (they explicitly discuss South Korea and Taiwan) are able to build more systemic approaches seems to be somewhat contradicted by the discussions of the developmentalist interpretation of energy and environmental challenges (see below).

Suzuki (2008) has conceptualized these as 'policy logics' pursued by different STI actors, i.e. organizations may follow one or many (also conflicting) logics from science, technology, commercialization, to finance, national prestige, autonomy etc. While these can be reflected on the *ideational level* (priorities and their justification), they are also likely to influence specific *organizational routines* of the STI policy organizations in terms of planning, staffing, coordination, network building etc (Karo and Kattel 2016a, b).

In the case of East Asia, several analyses (Angel and Rock 2009; Dent 2012; Kim and Thurbon 2015; Liou 2010; Seong et al. 2016) have noted that especially energy and environment related socio-economic challenges, which have been acute in East Asia since at least the high growth industrialization period and the 1970s oil crises (i.e. transformation towards domestic, low carbon and renewable energy sources and systems), tend to be 'framed' by politico-administrative elites of especially more developed countries (Japan and the East Asian Tigers) within the specific tradition of East Asian 'developmentalism' (Thurbon 2014).[3] While the political elites may rhetorically refer to global 'sustainable development' narratives, the actual policies are designed and implemented by traditional (or re-strengthened) developmental (state) bureaucracies, i.e. ministries or agencies for economic development and industrialization policy. These bureaucracies may be in turn supported by high-level coordination bodies presided by top politicians and also embedded in specific developmentalist public-private networks integrating selected non-state actors (mainly key firms and industries) into policy making and implementation networks (Dent 2012). In this context and while the sustainable development rhetoric often seemingly entails new burdens on firms and industries (through environmental regulations, taxes etc), the East Asian developmentalist policies are instead often framed in a mercantilist industrial or innovation policy logic that firstly supports local technological capabilities development to create and dominate new local and global markets (Kim and Thurbon 2015).

On the other hand, the growing liberalization and opening up of the East Asian economies since the 1980s (including gradual acceptance of WTO rules) and the evolution of these economies from technology importers and emulators to indigenous innovators and technology creators has already raised debates on whether and how the politico-administrative elite dominated institutional frameworks are able to support innovation-related activities in more uncertain and complex high-tech fields; and whether they are able to transform into new and more networked and co-governed forms through social and institutional innovations (see Chu 2016; Thurbon 2014; Fields 2012; Wong 2011). While these questions have been posed in the context of supporting market-based firm and industry-led innovation processes, they are relevant also for the societal challenges as the latter may require both basic technology creation and innovation as well as broader socio-economic changes (i.e. in consumer awareness and behaviour, changing focus from short-term financial wellbeing to long-term quality of life etc).

In the next section, we will analyse how the processes of justifying (ideational approach), drafting and implementing (institutional designs) challenges oriented STI policies are co-evolving two East Asian economies – Japan and Taiwan – given their specific politico-

[3] Idea*'that strategic state intervention into the market can facilitate industrial transformation and economic growth more generally'* (Wong 2004: 348).

economic legacies and contexts. We will focus on our three governance challenges identified while taking into account the organizational level issues regarding the co-evolution of policy logics and organizational routines.

3. Tackling societal challenges through STI policies in Japan and Taiwan

3.1. The domestic legacies of STI policies

Both Japan and Taiwan have shifted (from mid- to late 1980s onwards) from traditional industrial policy driven development strategies towards strategies were growing liberalization has been complemented with explicit STI policies supporting and coordinating R&D in firms and academia. This shift has also meant that next to the traditional economic policy bureaucracies (ministries for economic affairs), other actors (ministries for science and technology, government level coordinating bodies) have become increasingly important and visible. Since mid-1990s, there have been several attempts to transform the relatively fragmented STI systems to build more coherent approaches for the new STI based development strategies. In Japan, the key change were the adoption of the Science and Technology Basic Law in Japan (1995) that introduced the systems of STI policy planning through the 5-year Science and Technology Basic Plans. In Taiwan, the 1999 Fundamental Science and Technology Act in Taiwan formalized the role of the state in STI and coherent national strategic planning organized around the 4-year National Science and Technology Development Plan. In both countries, these strategies and plans are drafted and coordinated not by traditional developmental state economic policy bureaucracies, but by new high-level policy coordinating actors and existing science and technology policy bureaucracies. Thus, the implementation of these policies requires coordination between different actors with own specific legacies and routines, or policy logics.

Japan had inherited from the prior stages of industrial development a relatively fragmented and bureaucracy-led STI system where different ministries created own policy 'logics' (see Suzuki 2008) and arenas (of agencies, research performing organizations and feedback networks):

- Ministry of International Trade and Industry (MITI) and its STI funding agencies (NEDO) and research institutes (AIST) have been predominantly followed the logic of *commerc*e, i.e. promoting specific field for predominantly industrial competitiveness and commercialization; though, in the case of energy technologies, one of the key logics was also *autonomy* (from import dependence) to be achieved through development of new energy technologies (alternative sources, better conservation etc; see Watanabe 1995);[4]
- Science and Technology Agency (STA) under the Prime Minister tried to coordinate overall STI policies and supported (through JST and own research institutes) 'big' science (i.e. nuclear and space research) based on the logic of *technology* (to create national technological capabilities as the goal);

[4] Sawai (2009), Watanabe and Honda (1991), Watanabe (1995) show more nuanced co-evolutionary patterns between MITI's policy focuses and broader politico-economic context whereby MITI has sought to complement private sector focuses regarding STI (i.e. dependent on firms technological and financial capabilities and priorities, either focusing on basic, or more applied research).

- Ministry of Education, together with JSPS and public universities under its jurisdiction, followed the logic of *science* (to pursue science as inherently public good in a classical bottom-up and open search manner);
- The overall policy coordination and legitimation was dominated by the relatively close and corporatist 'council approach' whereby different core bureaucratic actors (ministries, cabinet of the Prime Minister) established different policy coordination and advisory council who bringing together selected members from politics, business, academic and media (Schwartz 1998).

The 1990s and early 2000s saw several attempts to overturn this relatively closed and bureaucracy-led policy making system, of which the 2001 administrative reforms were most profound and relevant for STI. In 2001, MITI was formally reformed into METI (Ministry of Economy, Trade and Industry; taking over also the tasks of the Economic Planning Agency), STA was merged with the Ministry of Education to form the Ministry of Education, Culture, Sports, Science and Technology (MEXT; the major funder of public R&D from this point onwards). Most public research institutes (in 2001; including METI's AIST) and universities (in 2004) were turned into independent agencies. In addition, two STI related high-level councils were established under the Prime Minister: Council for Economic and Fiscal Policy (setting overall targets for the national budgetary process) and Council for Science and Technology Policy (CSTP; before acting as advisory Council for Science and Technology) to take the role of 'control tower' for S&T policy through constant monitoring and coordination of priorities and activities of different actors. According to Suzuki (2008: 17), CSTP should have been the '*forum for the setting of national priorities for science and technology policy in order to strengthen industrial competitiveness and the national industrial base. In other words, the establishment of CSTP was driven by the increasing importance of the logic of commerce in all kinds of technologies, which meant that METI and CSTP share the same policy logic*'. At the same time, Stenberg and Nagano (2009) argue that given that the first Science and Technology Basic Plans were prepared by STA (and also given that CSTP and its office were staffed through secondments from STA/MEXT), the change of logics from science and technology to commercialization has been relatively gradual.

In the case of Taiwan, the following key legacy aspects should be mentioned:

- The development oriented economic bureaucracy – gradually concentrating within and under MOEA – pursued the logic *commerce* (for industrialization, creation of export capabilities) by relying on its own network of research institutes (i.e. ITRI and similar organizations) (see Greene 2008; Breznitz 2007) and other parastatal agencies for technology testing, certification, export marketing etc (Hsieh 2016)[5];
- In the organization of science funding and support, three actors – National Science Council (NCS) under the Executive Yuan, Academia Sinica under the Office of the President, Ministry of Education – have all sought to support science and technology development. In developing their specific policy logics, they have been largely dependent on the bottom-up nature and self-organization of science, i.e. while NSC has been over time tasked with both funding public research in universities and other

[5] Chu (2016) has argued that since the liberalization and democratization, much of this developmental bureaucracy has been influenced by the new neoliberal agenda.

organizations and promoting and coordinating nationwide S&T development (including decisions on national S&T policies, S&T resource integration and allocation guidelines, major S&T projects, important S&T laws and regulations), it has been largely dependent on the input provided by academics (especially from the Academia Sinica network) working in its different decision-making bodies and offices;

- But, since 1970s, this logic of science was counterbalanced by higher level politico-administrative and collegiate style of policy planning and coordination, e.g. cross-ministerial the Applied Technology Research and Development Team was established in 1976; in 1979 the Science and Technology Advisory Group was established as an additional mission-oriented body to steer S&T development programs, review the applied technology research development policy and provide recommendations to NSC and the Premier regarding STI policies and; in 1989 these bodied were merged into STAG (see Yearbook of Science and Technology Taiwan ROC 2012);
- In addition, the regular National Science and Technology Conferences initiated in 1978 (held in every 4 years; in 1990s, the approach was introduced also to specific policy domains such as energy) have functioned broader coordinating and legitimizing platforms where national strategic plans and priorities are proposed and deliberated and consensus on priorities is sought for. Overall, such institutions aided to guide the predominant logic of science funding towards industrial application and focus on technology and commerce.[6]

Given the gradual shift towards STI based development during the 1990s and 2000s, the government introduced in 1998-1999 several reforms to improve the top-down coordination and planning of STI policies. In 1998, regular Science and Technology Meetings/Conferences of the Executive Yuan were established (conveying every 3 months, chaired by the premier, attended by national S&T advisors and heads of STI related ministries); the regulation of STAG was changed to allow hiring prestigious foreign and domestic scientist and S&T advisors; the rules for the cross-ministerial and mission-oriented National Science and Technology Programs were introduced. The 1999 Fundamental Science and Technology Act formalized the system whereby the 4-year National Science and Technology Development Plan is drafted based on the results of regular National Science and Technology Conferences. The discussions of these Conferences are structured through both bottom-up 'issue selection' (solicitation and online publication of ideas from broad set of stakeholders to be discussed, negotiated and voted at the Conference) and top-down 'policy piloting' – government initiatives are summed-up in the White Paper on Science and Technology. The White Paper has 4 year timeframe and is adopted halfway (2 years) into the National Science and Technology Development Plan.

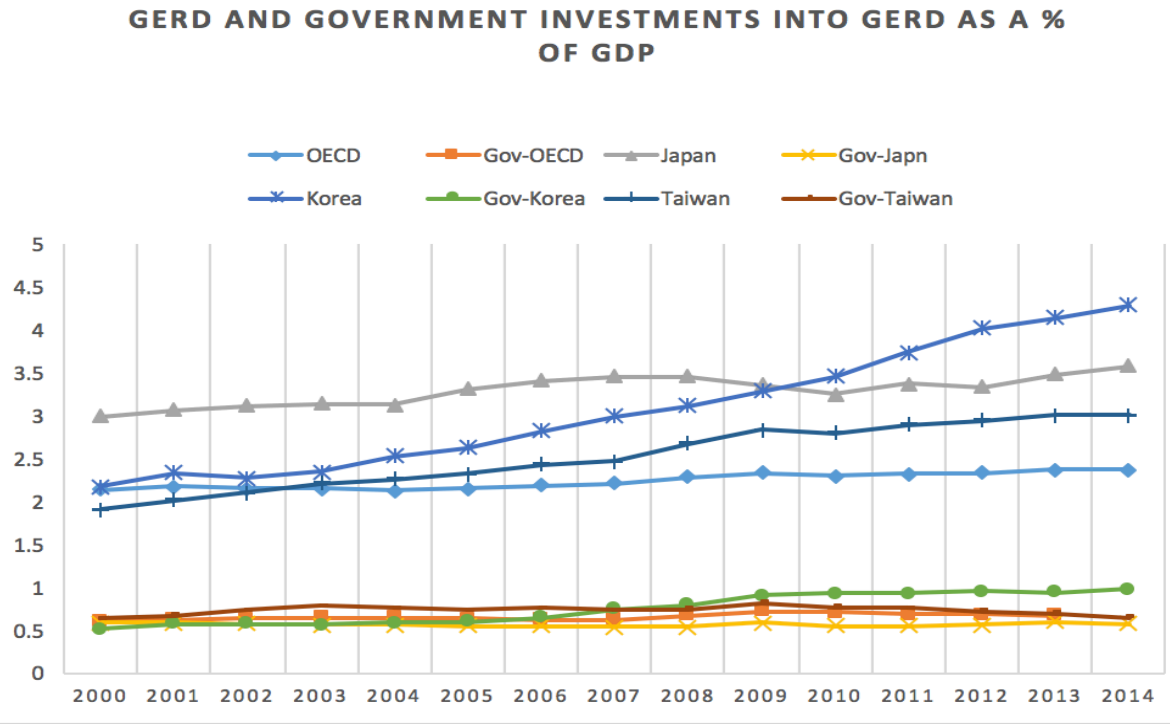
In this changing institutional context, in both countries (on Japan, see Stenberg and Nagano 2009), the first national STI policy strategies paid some lip service to societal challenges, but most focus of the strategies was on reinforcing the basic framework conditions of innovation systems (from human capital development to spurring university-industry collaboration and increasing general and public funding for STI) and improvement of the central, top-down planning and coordination of STI policies.

[6] As argued by Greene (2008: 68): *'academic research had been redefined, as early as 1959, as scientific research, and scientific research by 1964-1965, was being further defined as a combination of basic and applied research, pursuit of which could and should be justified in terms of national needs'.*

3.2. Ideational framing of challenge oriented STI polices in Japan and Taiwan

After the GFC and given the difficulties of sustaining previous levels economic growth and maintaining public STI funding (see Graph 1 and 2[7]), as well chance events (e.g. the 2011 Earthquake in Japan), both Japan and Taiwan started to introduce modern societal challenges oriented STI policy rhetoric and justifications into their key policy documents. In both cases, this change has been taking place through different political 'windows of opportunities'.

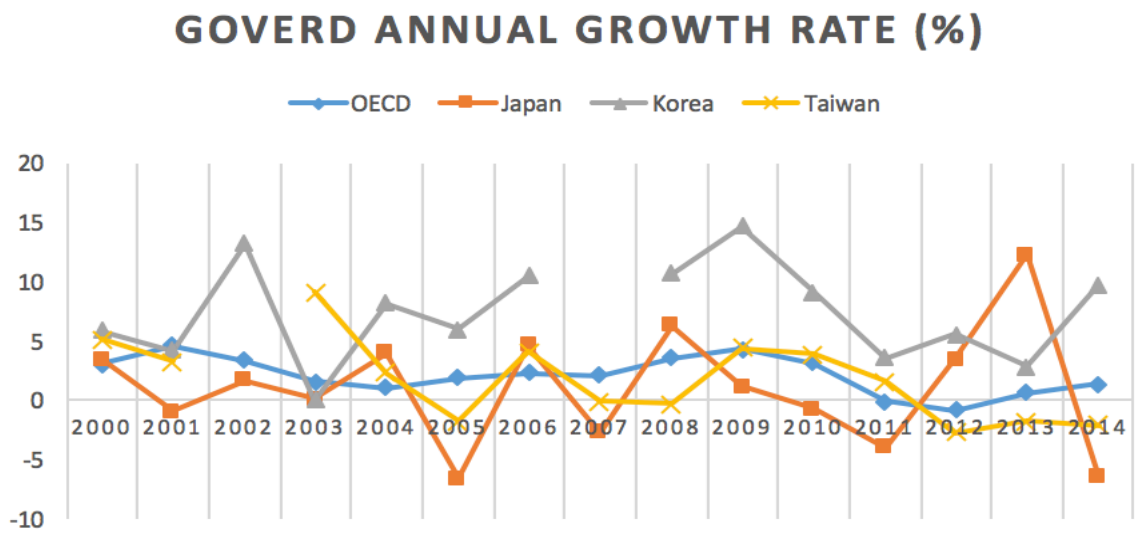
Graph 1



Source: OECD MSTI.

Graph 2

[7] In both cases, the governments have found it rather difficult to legitimize increased investments into STI. In Japan, the government has set since the first Basic Plan bold goals to significantly increasing public investment into STI (currently to increase investments to 1% of GDP), but has fallen short of stated goals during the 2nd, 3rd and 4th Plan. In Taiwan, the government emphasized for several years the overall goal of 3% of GDP invested into R&D, but even as the overall investments have almost reached the level, the governments itself has faced significant challenges in increasing the public STI commitments, especially as STI and economic development have not been (until recently) important topics in political competition (Chu 2016; Rosier et al. 2016).



Source: OECD MSTI.

In Japan, four interrelated stages of framing the societal challenges approach can be distinguished:

- The first attempt to substantially frame such policies emerged during the first term of Prime Minister Abe (2006-2007) who complemented the Third Science and Technology Basic Plan with the Long-term Strategic Guidelines 'Innovation 25' that framed three main challenges for the next 20 years: aging and population decline in Japan; explosive advancement of globalization, knowledge- and information-based society; threats to sustainability of earth. It emphasized the 'social context' of innovation (how innovations can solve the problems/challenges of people in Japan and globally) and the need to shift from 'industrial promotion' and 'government-led' type policies towards 'infrastructure creating' type policies that support through deregulation and conscious experimentation the ambitions and creativity of entrepreneurial actors.
- The Fourth Science and Technology Basic Plan (2011-2015) was adopted by the government led by the Democratic Party of Japan (2009-2012). Its economic policy program (New Growth Strategy 2010) was based on the rhetoric of shifting from 'public works based' development (1960-1980s) and 'market-fundamentalist productivity orientation' towards 'achieving economic growth by turning the problems faced by the economy and society into opportunities for creating new demand and employment'. Also the Fourth Science and Technology Basic Plan presented a 'crisis' narrative regarding both global issues (resources scarcity, political and economic instability) and Japan specific issues (aging, declining population and birthrate, economic stagnation) even before the 2011 Earthquake postponed and changed the adoption of the strategy. The Plan also attempted to shift STI prioritization towards more explicit *problem-solving* approach. The key policy focus was placed on (sustainable) growth oriented strategy in two areas of Japanese strengths – *green innovation* (developing low carbon energy sources, green social infrastructure and improving efficiency of energy resources) and *life innovation* (medical and nursing care, health services) – by integrating previously prioritized

technology domains (environment, energy, medical care, nursing care, and health) and policy logics (solving societal challenges while sustaining international economic competitiveness and creating future markets and jobs).[8] While the New Growth Strategy (2010) of the government operationalized these goals through 'market-oriented' performance indicators (global market shares and job creation opportunities; also the goal of reducing worldwide greenhouse gas emissions was measured in terms of emissions reduction created by Japanese private sector technology), the actual fourth Plan remained less clear on this issue allowing different actors to interpret the logic and justifications based on their own logics.

- The change of government after the 2012 elections and return of Prime Minister Abe resulted in the revisions of most economic policies under 'Abenomics' and the growth oriented Japan Revitalization Strategy 'Japan is Back' (2013). This plan is based on two focuses for economic competitiveness and STI. The *Industrial Revitalization Plan* seeks to induce structural reforms (in universities, regulatory environment for innovation etc) to create opportunities for existing industries to find new growth paths and to pursue 'all-Japan-efforts' in new STI 'frontiers'. The *Strategic Market Creation Plan* is based on the logic of creating new domestic and global markets by tackling current social issues (i.e. energy constraints, health and medical care, next generation infrastructure, revitalization of regions). With the adoption of the Comprehensive Strategy on Science, Technology and Innovation in 2013 and 2014, the government introduced similar revised STI visions (until 2030 and based on the ideas of Innovation 25) into the STI policy discourse.
- The Fifth Science and Technology Basic Plan 2016-2020 has in general continued the ideas proposed by Innovation 25 and Abenomics. To frame the overall approach to STI, the Plan proposes a new concept – super-smart society, or society 5.0 – that reflects an attempt to shift from technology and economic development driven STI thinking towards broader society- and human-centric approach. While the concept is consciously proposed in an open-ended way and still abstractly defined, the concrete policy actions of through Plan are specified through priorities that could be considered as technology oriented *missions* to coordinate the development of different socio-technical systems related to Society 5.0.[9]

In Taiwan, since the late 2000s, there seems to be a rather similar rhetorical shift taking place in the STI policy focus on logics. The 'sustainable development' and 'quality of life' priorities, emphasized in STI rhetoric since the first industrial development and STI related policy documents from 1960s onwards, have taken a clearer form and more central stage in STI

[8] The Great East Japan Earthquake lead to the revision of the strategy with recovery from the disasters operationalized as a separate essential challenge.

[9] In 2015, the following systems were selected as priority areas: optimizing the energy value chain, building a global environment information platform, maintenance and upgrade of an efficient and effective infrastructure, attaining a resilient society against natural disasters, Intelligent Transport Systems, new manufacturing systems, integrated material development systems, and promoting integrated community care systems, hospitality systems, smart food chain systems, and smart production systems. The concept of Society 5.0 requires the consolidation of key technologies (cybersecurity, IoT system architecture, big data analytics, AI, device technology, network technology, edge computing) and support for fundamental technologies that can create future value and where Japan has global edge (robotics, sensor technology, actuator technology, biotechnology, human interface technology, material/nanotechnology, light/quantum technology)

policy discourse, as well as in overall political competition between parties. This shift coincided with the return of KMT to government in 2009 (after being in opposition since 2002) and the severe impact of the GFC on Taiwan's development model (see Rosier et al. 2016). In 2011, the government Proposed 'Golden Decade National Vision' (formally also integrated into the National Development Plan of 2013-2016) where a new perspective towards economic, social and environmental goals was proposed (e.g. to change the growth model from efficiency to openness and innovation; proposal to substitute the indicator of GDP with GNH – Gross National Happiness). In terms of actual STI policies and plans, we can see a gradual emergence of the societal challenges conceptualization through two periods (at least until the new government was formed in 2016):

- The National Science and Technology Development Plan 2009-2012 and White Paper on Science and Technology 2011-2015 recognized that it will be increasingly difficult to maintain prior rates of economic growth. Further, the unbalanced economic, environmental and societal impacts of prior development eras require rethinking of the economic development oriented STI strategies and to shift from 'technology-oriented' to 'needs-oriented' model in STI development. The 2011 White Paper, while taking and explicit crisis narrative[10], proposed a vision that: '*Taiwan will become a global leader in green energy technology and intelligent living by 2020*' (prior Plans and White Papers had proposed the vision to achieve the level of technological development equal to developed nations by 2010 or 2015). Through both documents it was argued that such needs based approach should be based on 'innovation-oriented' as opposed 'efficiency-oriented' discoveries in which Taiwanese STI system had excelled since the 1970s; and that this would require a shift from the bottom-up driven to more top-down and coordinated STI policy making and planning to provide spaces for flexibility and the interdisciplinary blending of technologies. National STI priorities were operationalized as long list of priority domains, including both technological domain where Taiwan could success in global competition (e.g. computers and software, telecommunications systems etc) as well as domains that could led to solutions to emerging environmental and quality of life issues (e.g. control of epidemics, research and monitoring of natural disasters, prevention of environmental pollution etc).
- Given the difficulties of exiting the impacts of the GFC, securing funding for STI and overall debatable performance of the STI system, the National Science and Technology Development Plan 2013-2016 Plan (p. 22) raised more fundamental questions 'over the significance of a balanced development of and the link between technology, economy and society' and recognized that 'If economic growth could no longer guarantee to secure happiness, the distribution of resources should strike a balance between social welfare and economic development'. The STI vision proposed in the subsequent White Paper on Science and Technology 2015-2018 further departs from

[10] The 2011White Paper emphasized both global crises ('global recession triggered by American subprime loan crisis, the outbreak of new types of flu, environmental changes caused by overdevelopment, exhaustion of resources, and ecological imbalance') as well as Taiwan's own challenges ('A lack of natural resources, shortages of habitable land, a fragile natural environment, disputes concerning the precedence of economic development and safe living conditions, the effect of growing cross-Strait relations industrial development structure, the aging of society, and trend toward smaller families') for which social- transformations-inducing STI solutions were envisioned.

the growth-focused narrative by proposing the vision of '*using intelligent technology to create a prosperous society and achieve sustainable growth'* and introduces a concept of '*low-carbon intelligent society'*. While the concept is not defined in great detail, it is used as an umbrella term for the strategic activities aimed at establishing Taiwan as global leader in green technology; or, to transform Taiwan 'from energy importing country into a clean energy technology exporting country' through the development of green technology solutions and the distribution and consumption environments (from safety and disaster prevention networks to and low-carbon urban environments) (see White Paper on Science and Technology 2015-2018: 166-170).

In sum, in both cases the generic STI policies focusing on improving framework conditions (human capital development, IP protection systems, funding of entrepreneurship, academia-industry links) are being complemented by new attempts to provide some substantive direction and missions to STI policy. These directions attempt to increasingly bridge domestic socio-economic development needs and export-oriented economic development goals. In Japan, we can witness a somewhat more systemic and thorough shift which could be described as a shift from the developmentalist ideational framework towards modern entrepreneurial state and mission oriented logic whereby economic growth and development and societal challenges are increasingly operationalized as two sides of the same coin and focus of policies is on triggering private sector led technological developments within an overall direction (towards society 5.0) proposed by the government. In the case of Taiwan, the overall approach and evolution seems rather similar and many priorities and concepts emerge in a pattern that follows Japan, but the process of constructing the new STI policy logic is more recent and still emerging. In both cases, an important aspect is that the changes in policy rhetorical and priorities have been proposed and brought to the policy discourse during significant change events (changes of government, in the aftermath of large natural disasters). At the same time, as we show below, the implementation of these new strategic directions depends on the actions of different actors from science to economic bureaucracies and beyond. Given the legacies of the developmental state and the impact of the GFC, the industrial and economic development concerns (vs desired attempts to balance between economic and social/environmental goals) seem to still dominate in the actual policy implementation phase.

3.3. Governance of modern STI policies in Japan and Taiwan

In *Japan*, the emergence of the challenge/mission oriented STI policy logics has overlapped with several developments in the governance systems. Since the 2001 administrative reform, the CSTP has been expected to carry out the role of coordinating national STI policies. But this task was initially made difficult by several legacies of the prior system: each ministry was still tasked with own strategic planning and priority setting and negotiated individually with Ministry of Finance over actual budgets. Thus, CSTPs toolbox was rather soft: it could mostly react to proposals and ideas, but had limited tools for initiating new policy directions and initiatives.

Stenberg and Nagano (2009) claim that since the Innovation 25 and also influenced by the practical difficult of increasing funding in areas were Japan was making fast scientific progress (iPS research breakthroughs in 2007), global oil and food price fluctuations, GFC (especially

US stimulus package and investments into environment and energy STI), the Cabinet Office and CSTP tried to take itself the role of a dynamic 'change agent' in STI processes. CSTP introduced Top Priority Policy Issues as an additional layer of prioritization[11] and used the Special Coordination Fund (about 1% of total and 10% of competitive STI funding) to initiate cross-ministerial coordination projects. In 2008, it also initiated the Transformative Technologies Plan listing 23 technologies that could either revitalize existing industries and create new industries and markets (in some case also social impacts). The government also used the more flexible processes of supplementary budget drafting (i.e. in 2009 STI funds from supplementary budget equalled 38% of annual STI budgets) to initiate more proactive and dynamic programs and initiatives (i.e. Transformative Technologies Fund) with some also based on the DARPA-like[12] principal investigator (PI) focused instruments (i.e. the Funding Program for World-Leading Innovative R&D on Science and Technology) and more proactive 'all Japan efforts' to organize priority STI projects to be supported by more flexible regulatory environment (i.e. CEFP initiated 'Super-Special Consortia' for prioritized STI in medical research). Overall, the political leadership became more actively involved in the coordination and planning processes.[13] While some these initiatives were relatively short-lived – as the government changes in 2010 and refocused some of the initiatives –, they became core STI governance ideas of 'Abenomics' and new STI policy approach developed since.

Since the onset of Abenomics, CSTI has been consciously developed into the 'headquarters' of Japanese STI policies. In 2014, it was equipped with the Science and Technology Budgeting Review Committee through which the tasks and role of CSTI has in theory become more proactive (especially by coordinating cross-ministerial priorities before these are submitted to the Ministry of Finance) than the prior review and assessment of bottom-up proposals. Yet, the lack of sufficient organizational capacities in CSTI for monitoring and analysis of the policies and proposals of different organizations has led to both outside and self-criticism regarding the effectiveness of this coordination instrument. [14] Further, several experts claimed that given the weak capacities of the CSTI, it is not fully clear who is the de facto 'leader' of Japanese STI policy developments.

In addition, CSTI has introduced important attempts to directly implement its strategies and act not only as 'change agent' on the level of policy direction and justifications, but also in actual STI funding and implementation. Through its own budget (ca 4% of STI funding), it has initiated the so-called National Emphasis Programs – Strategic Innovation Program (SIP) and Impulsing Paradigm Change through Disruptive Technologies Program (ImPACT) – that continue the initiatives introduced in late 2000s: SIP continues the top-down cross-ministerial coordination initiatives of the CSTP (funded by the Special Coordination Fund) and ImPACT

[11] Transformative technologies, low carbon technologies, S&T diplomacy, regional empowerment through S&T, Pioneering projects for accelerating social return.

[12] Though, some local experts argued that this so-called DARPA approach of selecting and supporting PIs was in fact originally developed and used also by JST before the 2001 administrative reforms.

[13] Stenberg and Nagano (2009: 84) report that regarding the selection of the PIs for the FIRST programm, Prime Minister Aso claimed that 'I will make final decsisions myself when it comes to choosing the central researchers and research themes'.

[14] In addition, the Cabinet Office has tried to centrally coordinated other policy initiatives (e.g. creation of healthcare policy and R&D headquarters based on the UD NIH model, deliberation of New Low Carbon Technology Plan), but also in these cases there has been criticism of limited policy and administrative capabilities and overall fragmentation of STI related activities under the Cabinet Office.

carries forward the ideas of the FIRST program. Both place core focus on the selection of capable project managers/leaders (PIs) who are given extensive autonomy to design and implement concrete actions through team selection, R&D strategies etc. SIP program seeks to implement activities in national priority issue agreed by the CSTI (e.g. regarding energy, infrastructure development; see the Strategic Innovation Program 2016 for the list of activities) and through comprehensive coordination of STI funding, regulatory reforms and market support between different ministries to speed-up the processes of innovation (from problems and challenges to exits in terms of solutions and industrial applications). ImPACT program has been justified in terms of emulating the successful DARPA approach and conscious investment in the 'high-risk high-impact' topics with focus from basic research to commercially viable 'exits' (see Comprehensive Strategy for Science, Technology and Innovation 2014; ImPACT 2016).

Compared to the Western mission-oriented approaches, an important difference of the Japanese approach is that under the CSTI, these programs and projects are potentially under much stronger scrutiny (by public and other bureaucratic actors especially Ministry of Finance), which is quite opposite to the 'hidden' and 'protected' change agents approach of the US. This might create future problems regarding the evaluation and accountability of these high risk and experimental investments. Further, while there would be strong arguments to apply the portfolio approach to such initiatives like SIP and especially ImPACT, in reality this has not been the case. The performance of these programs will be still evaluated on the level of individual projects. The main goal for ImPACT funded projects will be the financial viability of the projects after the termination of ImPACT funding while SIP has set goal of actual showcasing of some of the result during the 2020 Tokyo Olympics. Thus, while the selection of project leaders and research topics has been rather flexible and entrepreneurial state like, the actual process of project implementation is much more bureaucratically regulated and monitored. For both programs, the main tool for managing risks seems to 'insource' legitimacy from the active role high level business representatives in the advisory and governing programs of these projects supported by regular (monthly) oversight of the project activities under the CSTI.[15]

The scope of the tasks of CSTI – drafting and evaluating S&T Plans, coordinating STI budgets, implementing programs in diverse sets of domains – make it look more like a generic ministry than mission-oriented change agent that seeks to initiate changes in specific policy/challenge areas. In addition, CSTI relies on the agencies of METI (NEDO) and MEXT (JSPS, JST) for actual project management and implementation. In other words, CSTI might be equipped with some dynamic capabilities to initiate change, but it lacks ordinary capabilities for actual STI policy implementation. Thus, STI strategies have also started to pay increasing focus on the organization routines and capabilities of STI funding agencies. For example, both JST and NEDO were recently (2015) designated as national R&D agencies to allow them to develop R&D specific organizational routines (longer time frames for performance and accountability etc). At the same time, under the guidance of their respective ministries, these agencies have been developing their own strategies and organizational routines. For example, METI and NEDO have pursued their own approach through developing strategic technology roadmaps and related technology management approaches, which look much more incremental

[15] In addition, the 2014 strategy proposed 2020 Tokyo Olympics as a showcase benchmark for many initiatives.

innovation and commercialization oriented that the CSTI 'high-risk high return' logics (see Yasunaga et al. 2009) as well and societal challenges related experimentation logics. NEDO officials claim that when managing and implementing SIP projects, NEDO still follows its own managerial approach (except for evaluation and reporting which is based on CSTI guidelines), though project managers have strong influence over the direction of the project.

Overall, the evolution of the policy ideas and attempts to frame challenges/missions next to generic framework conditions improving STI policies seem to still be influenced by the policy and administrative legacies of the STI system. It was commonly argued by many MEXT and CSTI related experts that these attempts to bridge scientific research and economic development policies under common umbrella have had little effect on METI who has enjoyed its own financial independence (i.e. energy special account) as well as political links to the Cabinet independent of CSTI. It has been recognized that METI still focuses on its logic of commercialization and instead of the Society 5.0 it prefers to frame policies through narrower and economic development oriented concepts of Industry 4.0 or 4th industrialization. In other words, METI supports the societal challenges policy logic when it serves its commercialization and industrialization goals. At the same time, it the recent policy and instrument level initiatives of CSTI seem to have more impact on MEXT whose existing role and tasks seem to be challenged by CSTI. While CSTI seems to build the entrepreneurial state logic based approach to societal challenges (focus on high risk projects, steering firms and industries to tackle socio-economic issues), MEXT policy networks seem to be building more science-driven logics and more bottom-up transition management type approaches (e.g. see the methodology and proposals by the Centre of Research and Development Strategy of JST).

In *Taiwan*, the emerging policy rhetoric of needs-based and innovation-oriented STI policies has been paralleled by rather similar tendencies to centralize STI policy design and implementation while also trying to find ways to support experimental STI initiatives.

In 2012, the government formed a new high-level coordinating body – Board of Science and Technology (BOST) of the Executive Yuan – that is presided by the Executive Yuan premier and includes heads of key agencies, members of industry, academia and research organizations. The tasks of BOST include: reviewing country's S&T policies; allocating country's S&T resources; reviewing and supervising major S&T development programs; coordinating, integrating and promoting interagency S&T matters; organizing and holding major S&T strategic planning conferences. In principle, BOST institutionalizes prior more fluid policy coordination activities (through STAG, NSC initiatives etc) and elevates to higher status tasks formerly carries out by the NSC. It is supported by the Executive Yuan task force Office of Science and Technology. Thus, in its role and structure, it is quite similar to the CSTI in Japan. Yet, it was argued by local experts that as a relatively young body presided by the premier, its role and tasks (and role divisions with other actors) are rather fluid and depend on the policy priorities of the premier and government in specific times. Further, its STI-related tasks are influenced by the National Development Council (NDC) also created in 2012 (based on the Council of Economic Planning and Development) as a sort of 'mini-cabinet' to debate new policy initiatives proposed by the ministries (especially regarding social and infrastructure investments; while 'pure' STI proposals are debated by BOST) before these are decided by the Executive Yuan and initiate new industries and initiatives. In principle, NDC's

Department of Industrial Development seeks to foster national scale industrial policies with a focus on technological development, special industrial development, improvement of employment rate, GDP growth, regional development. Thus, as argued by local experts, while BOST focuses on industries with existing potential, NDC deliberates also wider prospective industries, such as IoT, and in these cases, the role of the NDC is to be in charge of overall planning, review of other ministries, creation of a common platform for discussions, budget coordination especially regarding big spending on infrastructure. Local experts also argue that the role of NDC has become more central after the 2016 elections with national industrial priorities and frameworks proposed by NDC.

In 2014, Ministry of Science and Technology (MOST) was established based on NSC, but with additional roles and competencies (new departments) regarding foresight and innovation policy as well as academia-university collaboration. Formally, the tasks of MOST include: formulation of county's S&T policies; drafting, coordination and assessment of government S&T development programs and review of the S&T budget; promotion of basic and applied S&T research[16]; promotion of major S&T R&D programs and support for academic research; drafting, promotion and management of forward-looking industrial technology R&D policies and technology assessment; development of science parks; management of National Science and Technology Development Fund. In other words, the creation of MOST has, on the one hand, raised the political visibility and debates over STI strategies and policies (NSC was under the Executive Yuan, but as ministry, MOST has to be accountable also to the Legislative Yuan) and, on the other hand, increased the expectations on the strategic priority setting in STI policies and the speed and scope of academia-industry technology transfer. Overall, the new governance system has become relatively mainstream spearheaded by political level coordinating institutions (government meetings, BOST, NDC) and based on two key ministries (MOST and MOEA[17]). Yet, there have been two rather unique elements in the system.

First, these organizations still rely on and continue creating new high-level advisory boards. Before the administrative reorganizations, STAG was the main advisory group functioning through ad hoc and annual meetings. With the creation of BOST, such advisory and coordinating role became more institutionalized and systemic. In addition, in 2012, NSC initiated a new Science and Technology Development Advisory Conference which has proposed new approaches to main policy tasks of MOST (i.e. to adopt DARPA approach in mission-oriented projects etc) (see White Paper on Science and Technology 2015-2018: 26-27). Also in 2012, the government introduced the National Industrial Development Conference. In addition to these generic conference, also domain specific meetings are still

[16] The 2011 White Paper envisioned the division of STI funding so that MOST finances most basic and applied research while while other other S&T-related agencies fund S&T development and industrialization. Further, it justified the creation of MOST in terms of increasing economic impact of STI: 'It is hoped that the new organizational system will effectively join up-, mid-, and downstream S&T development activities, give stronger roots to high tech industries, and boost industry's added value by letting R&D results guide improvements to the industry structure. In the future, the unification of services and powers at the Executive Yuan Science and Technology Meeting, Ministry of Science and Technology, and other relevant agencies will accelerate innovative R&D, enable the effective allocation of S&T resources, and realize the vision of using S&T development to strengthen national competitiveness'.

[17] In recent years, MOST has funded about 40% of STI, MOEA about 28-30%, the allocation to Academia Sinica have equalled about 12% of all government STI funding and Ministry of Health and Welfare and Council of Agriculture have covered about 4% or less (see White Paper on Science and Technology 2015-2018: 30-31).

used to draft policies and strategies (e.g. since 1998 National Energy Conference has been held regularly; since 2002 annual Strategy Review Board Meetings for Science and Technology are held). Especially national level conferences (general science and technology conference, national energy conference) have introduced more open-ended participatory modes of policy-making (web-based solicitation of ideas, which are pre-assessed before public deliberations for feasibility by the experts) and inclusion of civil society organizations among conference members (importantly, these conferences are asked to come up with unanimous conclusions that would ideally guide policies and strategies).

Second, an even more noteworthy element of the Taiwanese system is the lack of STI funding agencies under the respective ministries (such as NEDO, JST, JSPS in Japan) as the 1999 Fundamental Science and Technology Act did not foresee such bodies. Rather, the ministries are still in direct interactions with STI performers: in the case of MoEA, its different departments and bureaus are closely linked to public research organizations such as ITRI; in the case of MOST, similar role is fulfilled by NarLabs, but it also funds predominantly universities (under the Ministry of Education) and Academia Sinica (under the Office of the President). While in the case of bottom-up funding of research organization, the lack of such specialized agencies was not seen as a problem, in the case of dual tasks of bottom-up and top-down funding of STI, it may be more difficult to combine these tasks into the same organizational structure and routines of the ministry. In such governance system, one can't also talk about specialized mission-oriented change agents, at least in the Western sense, that trigger changes in specific challenge areas (especially as the STI tasks and roles of universities and public research organizations are in each case of supporting technology development divided based on the technology readiness level analysis and similar approaches that divide the STI supply and diffusion tasks rather linearly). The role of 'change agents' is still carried out by old and established STI performers – such as Industrial Development Bureau of the MOEA, ITRI and other parastatal agencies. Yet, as was argued by ITRI officials, in drafting their research strategies and programs (in the area of green energy[18]), ITRI follows MOEA's guidance, white papers (e.g. Energy Industry White Paper) and strategies as opposed to the national STI Plans and strategies. While these documents emphasize the need to combine energy, economic and environmental concerns (so called win-win-win logic), it is also recognized that specific strategic planning tools (technology readiness assessment tool, technological roadmaps etc) are more geared towards incremental and efficiency driven policies rather than supporting high-risk and transformative innovation oriented policies and rethinking socio-technical development patters as prioritized in the overall STI rhetoric. Therefore, the coordination of the strategies and missions of different actors and translation of new policy goals into concrete actions is still dependent on high-level policy coordination across ministries and mediated by top-level civil servants and politicians.

While on the level of policy-making, we witness increasing political and administrative centralization of STI policies (through BOST, MOST, NDC and other bodies created by Executive Yuan), on the level of policy instruments designed and implemented by these actors, we see also some emergent elements of the risk-taking and experimental approach regarding both market-supporting and challenges-oriented activities. Since 2012, different

[18] Alternative energy, energy conservation and related activities have been important policy focus of MOEA since late 1960s (initially under Energy Policy Deliberation Groups and since 1979 under the Energy Commission; became Bureau of Energy in 2004.

organizations have tried to introduce new policy instruments that consciously adopt more flexible organizational principles (from selection to management and performance indicators) to foster cross-sectoral collaboration in high-risk and future oriented domains. NSC and MOEA jointly launched the PIONEER Grants for Frontier Technologies Development by Academia-Industry Cooperation to undertake high risk R&D in forward-looking technologies and to support firms through IP protection, human capital development etc.[19] Other similar instruments include Academic-Industry Technological Alliance Projects to set-up core technological R&D laboratories (in 2013 75 project were funded) and Applied Research Incubation Projects to fund forward-looking, original and early research that is product oriented and with application potential. (See White Paper on Science and Technology 2015-2018: 110-114). On a more individual level, NSC initiated 100 Person Pioneering Trial Program to support non-conventional and high-risk and exploratory research ideas (the plan foresaw 2-year project with annual funding of 1 million TWD to be evaluated after 1 year with at least half of the project to be rejected for further funding). The Free Excellence Academic Research Trial Program was designed to high-risk and forward-looking strategies and capabilities building on the organizational level. (See Ibid. 122-123)

While most national S&T Programs – that were the key national priority setting and policy coordination tools throughout the 2000s – have been closed down, the only continuing National Energy Program – NEP – was significantly revised after the first period ended in 2013. While the first phase of NEP – organized under the NSC – was organized in a relatively bottom-up manner and following the logic of science (and it was largely managed by university scientist themselves), the NEP-II is co-financed by MOST, MOEA and industry and under the closer supervision of MOEA (the PI is the current vice-minister of MOEA). Also, the 'outsourcing' approach (open calls for project ideas) has been substituted with more targeted and mission-based approach (the general and domain leaders plan R&D priorities and select teams to fulfill these projects) and provided with clearer phase-out mechanism and performance targets. (See White Paper on Science and Technology 2015-2018: 97-100) The projects are selected, coordinated and managed based on the technology-readiness level assessment whereby the basic research level activities are carried out in universities and financed by MOST, but more mature technologies and activities (from concepts to product testing) are gradually moved to public research organization such as ITRI to be eventually spun out to industry. Overall, the Program has become less science driven and more state and bureaucracy-led and controlled. At the same time, MOEA official still admit that there is a gap between MOST and MOEA as MOEA focuses on projects with 2-5 year timeframes while most of NEP-II projects focus on technologies that will be usable in 10-20 years. And while the focus has been placed on commercialization, it is foreseen that MOEA and ITRI need to take the lead in the latter. Further, given the priorities of the new government to shift to nuclear free and low carbon energy system by 2025 (under the previous government these were treated

[19] In 2013, 2 projects including TSMC and China Steel Corporation had been initiated based on the logic that corporate partners formulate research questions, organizes a team with applicant university to jointly pursue forward-looking R&D. It is expected that the corporate alliance co-financed at least 80 million TWD of the Project (40% research related) while the government (MOST, MOEA) contribute up tp 400 million TWD annually for up to 3 project in total.

as complementary focuses), most of existing policy priorities and coordination mechanism are currently revised under even higher-level oversight.[20]

For most STI projects in Taiwan, rather similar 'tables' of performance indicator tables are compiled (e.g. covering publications, defended MA and PhD theses, patents, technology transfers, industrial investments, new companies, jobs, in the case of energy projects some specific targets: awards, CO2 reduction, environmental impact). But as argued by local policy experts, depending on the context, the same table may be used, but it is read 'differently' (i.e. some indicators matter more than others). Further, these indicators have been used as additional information source and not definitive tool for policy evaluation, which is often based on collective decision-making principles on program or institution level (as opposed to single project level). At the same time, several local experts also argued that the elevation of the NSC to the ministry level has increased parliamentary oversight of STI activities and increased the focus and political scrutiny based on few cherry picked key performance indicators as opposed to more systemic evaluations and discussions.

4. Discussion

In the context of the growing emphasis on challenges-, needs-based, or problem-oriented STI policies, we can see both in Japan and Taiwan attempts to introduce similar policy logics by mixing the specific developmentalist legacies of bureaucracy-led STI policy-making and modern mission-oriented and entrepreneurial state logics regarding the role of the state in STI: state is seen increasingly as a pro-active and entrepreneurial actor leading firms to new emerging industries and markets through targeted, experimental and high risk approaches to STI funding and governance. While the global research on societal challenges and STI would lead one to expect either more hidden and specialized change agents and/or co-productive and participatory policy approaches where social actors are included in the policy processes, we seem to witness the continued impact of the developmenalist legacies: the state tends to centralize such high risk and uncertain activities in high-level policy making bodies where close-knit politico-administrative networks dominate over other feedback sources.

At the same time, these high-level bodies – CSTI in Japan and BOST/MOST in Taiwan – currently lack direct access to 'change agents' who would be specialized in specific challenge areas and equipped with necessary dynamic capabilities to trigger systemic socio-technical changes needed to tackle the boundary-spanning and complex challenges in e.g. healthcare systems and environmental/energy sustainability. Rather, they have to rely on policy coordination and collaboration with other ministries – especially METI and MOEA – and their respective STI funding and implementing agencies. Yet, these organizations seem to be more embedded in their traditional organizational routines and policy logics of commerce or industrial development. Both in Japan and Taiwan, it was recognized by different experts that the new narratives constructed through national STI plans have had limited impact on the policy arenas under respective ministries of economy. As a result, the Japanese CSTI, while trying to act as a new high-level change agent steering the direction of the STI discourse and policies, has also tried to centralized many tasks of STI policies into the highest-level political

[20] In 2016, the new government set-up a new Executive Yuan level Energy and Carbon Reduction Office that report to the premier to further improve the top-down coordination of renewable energy policies (pursued by MOST, MOEA, Environmental Protection Agency).

institution (Cabinet Office). While this may provide authoritative capacities to steer and coordinate strategies and instruments of different ministries – though it seems to require much higher organizational capabilities than assumes so far – that may spill over to research funding and implementing agencies, it creates opposite threats of simplistic public and political criticism of 'high-risk high-return' investments and policy experimentation, both of which are bound to lead to significant and expensive failures. In the case of Taiwan, the role of executive leadership and its changes in recent decade seem to matter more for overall policy shifts than the attempts of BOST/MOST to influence the overall direction of the system.

Existing literature on boundary-spanning societal challenges seems to indicate that tackling such challenges may require either more participatory approaches to governance and by more systemic approach to policy evaluation and feedback. Regarding these aspects, it seems that the Taiwanese STI policy system may have – through the more open-ended system of conferences and committees as well as recent trends to consciously include NGOs and civil society organizations in such bodies – more open-ended mechanism for participation in STI policies than more corporatist Japanese system where politico-administrative elite has traditionally collaborated with more select groups of industrial stakeholders. At the same time, the importance of chance events and power changes as the triggers for changes in STI policy discourse implies that these bottom-up processes may introduce new ideas and expectations, but the top-down political choices and priorities may still matter more. The development of portfolio approach or more participatory mechanisms to policy evaluation could be so far unused solutions that both countries should consider in order to focus policy evaluations and accountability on more systematic view of STI policies, especially given the nature of the high-risk and high return and experimental approaches to STI policy design and implementation

In sum, while we see rather similar developments to global trends on the level of policy ideas/rhetoric and the design of specific instruments, an alternative form of governance seems to be emerging and evolving in East Asia that is influenced by the politico-administrative elite centred legacies of 'developmentalist' policy-making and priority setting.

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