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How to Organize for Innovation: Entrepreneurial State and Organizational Variety

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Abstract

Research on how to effectively organize innovation policy has seemingly come to a consensus that decentralized, often peripheral, flexible and specialized organizations are superior to monolithic and hierarchical bureaucracies. These agencies are expected to both support innovation *in* markets through effective implementation of government interventions and, if necessary for the former task, also innovations *in* public policies, institutions and organizations. Yet, it is also recognized that policy innovations and effective implementation of policies may require organizations with different routines and capacities. We propose that we might gain a more systematic understanding of this governance challenge by focusing on the *organizational morphology* of innovation policy design and implementation and its *evolutionary variety*, or ability to sustain different policy and administrative capacities deemed necessary for effective innovation policy. We propose an analytical taxonomy that systemizes the diversity of organizational routines and capacities using the organizational configurations proposed by Henry Mintzberg. We illustrate through three critical cases that effective innovation policies are based on a variety of organizations with different routines and capacities. We also discuss the policy implications and avenues for further research.

Introduction

In recent years, many prominent innovation scholars (Mazzucato 2013; Block and Keller 2011; Fagerberg et al. 2013; Zysman and Breznitz 2012; Weiss 2014) have argued that if technological development and innovation is to significantly contribute to solving current economic and societal challenges, the thinking on the role of the government in innovation should be extended beyond the narrow perspective of governments mostly fixing market failures. The so called entrepreneurial, or modern mission-oriented state should build policies and institutions that proactively take on the *uncertainties* of technological development and innovation (Mazzucato 2013). This argument can also be taken as a self-criticism of the innovation policy scholarship and practice. Freeman (1987) argued already in the early years of the systems of innovation thinking that radical technological innovations and changes in technology systems and techno-economic paradigms (see also Perez 2002) require complementary institutional and social innovations. Thus, the role of the state is to both support innovation *in* government policies, institutions, organizations (this is now labelled as public sector innovation) and innovations in markets *through* government actions (this is what we usually label as innovation policy).

Yet, our knowledge of *how* to do this seems to be somewhat limited. Empirically, the Asian *developmental state* (Johnson 1982; Evans 1998) and the Western *mission-oriented innovation policies* of the Cold War era (Mowery et al. 2010; Foray et al. 2012) are probably closest to the current entrepreneurial state thinking, even if current the techno-economic context (in terms of policies, institutions, markets and diffusion pathways) may be more complex (Karo and Lember 2016; Wong 2011; Yeung 2013). Thus, in her recent paper, Mazzucato (2014: 8) argues that one of the crucial questions for the innovation research is to understand the internal workings of what we call in this paper ‘innovation bureaucracies’, i.e. *‘how should public organisations be structured so they accommodate the risk-taking and explorative capacity, and the capabilities needed to envision and manage contemporary challenges?’* Further, *‘key concern should be to establish which skills/resources, capabilities and structures are useful to increase the chances that organizations will be effective both in learning and establishing symbiotic partnership with the private sector – and ultimately succeed in implementing mission-oriented and transformative policies’* (Mazzucato 2014: 17). These questions are also highly topical in development policy research (Easterly 2014; Reinert 2007) and public sector innovation research (see de Vries et al. 2015; Kattel 2015).

In this paper, we propose that these questions are best answered by an analytical framework with an explicit *organizational focus* – looking at innovation bureaucracies through the lens of organizations and organizational morphologies (or, systems of organizations) – as opposed to individual or institutional level analyses. This is one of the core premises of the evolutionary economics research on technological change and innovation (see Nelson and Winter 1982). We show that from this perspective, we can find two almost juxtaposing views on innovations bureaucracies, associated with two great social scientists: central meritocratic and hierarchical expert organizations (labeled as Weberian bureaucracies) deliver innovations versus small, agile and often peripheral or decentralized organizations (labeled as Schumpeterian organizations) do a better job at innovations than others. The debate on the role of the state in innovation often gets stuck just at this juncture searching for the definitive answer to the question: should we still stick to modernizing Weberian meritocracies, or move radically towards experimental, start-up like governments?

We aim to show that innovative bureaucracies are much more complex phenomena and require a more elaborate framework and thinking. On the theoretical level, we show that the arguments in favor of Weberian vs Schumpeterian agencies are in fact not mutually exclusive, but highlight the complexity of how government organizations need to be structured

and organized to support innovations both *in* government (policies, institutions, organizations) and also *through* government (innovation) policies in firms and industries (to achieve desired policy impact, e.g. tackling societal challenges and increasing productivity and economic growth). In other words, well performing innovation bureaucracies consist of a *variety of organizational configurations* (see also Mintzberg 1989) and capacities that foster both constant search for better policy ideas and practices and implementation of these ideas and practices in an effective manner and with a desired systemic impact.

In section 1 we briefly review the existing literature on how to organize the design and implementation of innovation policies – here, we understand innovation policy in the widest possible sense including all public policies that consciously aim to promote innovations and technological change (see also Lundvall 2013). In section 2 we provide our analytical taxonomy of organizational configurations and elaborate the concept ‘organizational variety’. In section 3 we apply this taxonomy to stylized case studies (based on literature review of three ‘critical cases’) of how governments have organized innovation policy in different contexts. In the concluding section we provide guidelines for future research and policy.

1. Classic and modern debates on innovative bureaucracies

1.1. The classics

As with most social science research, we can dissect research on innovation bureaucracies into three inter-related levels of research – individual, organizational and institutional – pursued by sociologists, economists, organizational theorist and others. Most of the questions on how to organize innovation bureaucracies posed by Mazzucato (2014) were among the core topics also in the works by Weber (1922), Schumpeter (from 1912 to 1942), Merton (1940), Hayek (1945), Simon (1952). These scholars were among the first to provide modern systematic scientific inquiries into such questions as what are the potential trade-offs between organizations/bureaucracies as the key characteristics of modern societies (see also Cohen 1970) and individual, interests, motivations, wants?; and how organizations and societies in general maintain dynamism, change, and innovation?

Weber and Schumpeter were among the first trying to build comprehensive evolutionary/dynamic perspectives on these questions (see e.g., MacDonald 1965 and Ingham 2003 for comparisons of their perspectives), but their thinking is often simplified into opposite views: Weber’s work is related with hierarchical organizations and bureaucracies and

Schumpeter's with individual entrepreneurship. Of course, Weber's ideal-types and broader analysis of economy and society recognized both 'charismatic' and 'rational' (and 'traditional') forms of authority underpinning the organization of social life (Weber 1922) and Schumpeter moved from emphasizing entrepreneurs (and their personal qualities) to organizations (firms) as crucial sources of innovation (see Schumpeter 1912, 1942). Witt (2002) argues that this shift in Schumpeter's work partly shows that his approach lacked the necessary traits of an evolutionary theory, especially the 'self-transformation explaining' aspects, or 'endogenous drivers' of change of the system in focus.¹ Somewhat similar criticism is also raised regarding Weber's work (see MacDonald 1965). Indeed, both Weber and Schumpeter gave most emphasis to exogenous factors – unique individuals, both charismatic entrepreneurs and financiers; and specific cultural-religious aspects – as drivers, or triggers of change. Perhaps the key common feature in the work of Weber and Schumpeter is the understanding that conflict between incumbent and new (political, business, etc) ideas always also takes organizational shape.

Later evolutionary attempts have tried to include also technology as important variable in itself into the analysis noting co-evolutionary ties between technological, organizational and institutional developments (see also Nelson 1994). Litwak and Figueira (1968: 468) were among the first to explicitly link the debates on the trade-offs between individual vs bureaucratic ways of organizing social life and specific impact of technologies and technological development:

Bureaucratic structures are ideally suited to deal with problems requiring technical knowledge or large-scale capital investments. Primary group structures are most able to handle problems requiring little technical knowledge, for example, where knowledge is so simple the ordinary person can do it as well as the expert, where knowledge is lacking so experts cannot be trained, where knowledge is so complex it cannot be put together in time to make a decision. In principle, technology is as likely to take tasks now handled by experts and simplify them so the ordinary person can deal with them as it is to take tasks now handled by ordinary individuals and show how they can be more effectively handled by experts. Therefore, in principle, technology is not likely, after its first stage, to reduce functions of either the primary group or the bureaucracy. More characteristic will be stress on continuous change.

¹ According to Witt (2002: 10) an evolutionary theory in whatever field is a) dynamic, b) historical (deals with historical processes that are irrevocable and path dependent), and c) self-transformation explaining (includes hypotheses relating to the source and driving force of the self-transformation of the system, be it be it firm, industry, government).

In this context, and departing from the understanding that innovation does not equate invention or just any kind of change, but denotes a more complex process of 'successful' applications of new technical or social knowledge (or application of existing knowledge in new context) (see OECD 2005), evolutionary economics and innovation research has taken an explicit organizational focus. The crucial contribution is Nelson and Winter's (1982) work on evolutionary economic theory and their focus on organizational 'routines' as the key factors explaining firm and industry performance (see also Becker 2008; Nelson and Nelson 2002). As succinctly defined by Hodgson (2008: 23): *'Routines are not behavior; they are stored behavioural capacities or capabilities. These capacities involve knowledge and memory. They involve organizational structures and individual habits, when triggered, lead to sequential behaviours'*. The complexities and uncertainties of innovation require organizations to 'store' (routinize) existing (tacit) knowledge and mediate between institutional and individual level drivers (environmental feedback, individual motivations and wants) that influence (drive and constrain) innovation processes. Thus, modern private sector innovation research focuses to large extent on organizational performance (capabilities) and implementation of strategies (e.g., how to keep creativity in an organization? what products and business strategies are feasible in specific institutional contexts?; see Lam 2006 for an overview).

1.2. Modern debates on organizing innovation bureaucracy

Nelson and Winter also argued that *'If one views policy making as a continuing process, the organizational and institutional structures involved become critical. Public policies and programs, like private activities, are embedded in and carried out by organizations. And, in a basic sense, it is the organizations that learn, and adapt. The design of a good policy is, to a considerable extent, the design of an organizational structure capable of learning and of adjusting behavior in response to what is learned'* (Nelson and Winter 1982: 384). Still, innovation policy (but also development policy and public sector innovation) research has done much less work on this level of analysis. Instead, one can find ample research on *institutional level* (what are the best institutions or governance systems for supporting technological and institutional innovation and economic development in general? – see Fagerberg et al. 2013 as the most recent recap of the system of innovation research and its contributions; Easterly 2014 and Reinert 2007 on development policies more broadly) and *individual level* (who are public sector entrepreneurs, how do they emerge and survive in bureaucracies and how they support innovation in policies and markets?; see Leyden and Link 2015). As a result, the analysis of organizational capabilities has been substituted mostly with references to

neo-institutional approaches to state policy and administrative capacities treating institutions mostly as constraints and not as enablers, or drivers of innovation (see Nelson and Nelson 2002; Karo and Kattel 2014).

One crucial exemption here is the debate started by the East Asian *developmental state* scholars in the 1980s (Johnson 1982, Amsden 1989, Evans 1995 and 1998, Haggard 1990, 2004, Wade, 1990). According to Evans (1998; also Haggard 2004), a common assumption across different theoretical focuses (on 'market-friendly' policy rationales, 'industrial policy' rationales, or 'profit-investment nexus') explaining East Asian development since the 1960s was that '*highly capable, coherent economic bureaucracy, closely connected to, but still independent of the business community, has been essential institutional prerequisite for successful innovation policy*' (Evans 1998: 66).² While in these different models governments follow diverse policies with different degrees of intervention and economic bureaucracies have diverse definitional and task-related borders (from generic regulation to sector specific targeting, finance and regulation), the assumptions of policy and administrative capacity have been rather uniform. Namely, it has been *assumed* that whatever the policy and institutional variety between specific economies, bureaucratic capacities can be best developed and best talent recruited and motivated via *Weberian* (in the sense of rational authority) *means* of *meritocratic recruitment* and *career management* to make working for government either financially competitive to, or culturally even more rewarding/prestigious than, working in the private sector.

Quantitative studies have sought to solidify this position (see Evans and Rauch 1999; Rauch and Evans 2000; more recently Nistotskaya and Cingolani 2014), but they test the importance of some more easily measurable Weberian elements (merit-based recruitment and career systems) on system level without explicitly looking at and into innovation bureaucracies. Furthermore, also the qualitative studies following the pilot study of Johnson (1982) who studied the organization of Japanese MITI in great detail (structure, recruitment strategies, evolution of tasks etc) have taken a more institutional perspective (assuming the existence of general Weberian structures also in specific policy domains and organizations).

² This view is still most elaborately captured by Chalmers Johnson's concept of the *developmental state* and research on Japan: a country with predominant policy orientation towards development supported by a small and comparatively inexpensive elite bureaucracy centered around a pilot organization, such as MITI, with sufficient autonomy (limited intervention by the legislative and judiciary) to identify and choose the best industries and technologies to be developed as well as the best-fitting policy instruments (from administrative guidance to control over finance and regulation of competition) while still maintaining market-conforming methods of state intervention, and public-private cooperation in state-business relations (Johnson 1982, 305-320).

Only since the late 1990s have some studies tried to replicate the original claims of the broader developmental state research (see Cheng et al. 1998; Kang 2002a; 2002b). They have revised the original claims and related assumptions and highlighted how the Weberian elements have in fact varied and also from time to time been overlooked in different countries. Thus, a more revised approach on how to create bureaucracies supportive of innovation emphasizes developing minimally some *islands* or *pockets of excellence* in government – as *insulated agencies* – that can design and implement policies supportive of complex tasks of innovation and development (see again Evans 1998). This thinking has permeated much of the innovation and development policy research from Latin America (Schneider 1992) to Eastern Europe (Suurna and Kattel 2010) and beyond (OECD 2005; Edquist and Hommen 2008).

At the same time, Western insights from the so-called neo-developmental state research (O’Riain 2004; Block 2008) and mission-oriented innovation policies (Mowery et al. 2010; Foray et al. 2012) and also more recent studies of East Asian Tigers trying acting closer to the technoeconomic frontier (in ICT and biotech) (Yeung 2013; Wong 2011; Zysman and Breznitz 2012) have provided somewhat different interpretations questioning the validity of the developmental state thinking. For managing the uncertainties of innovation and development at the technoeconomic, institutional set-ups of innovation policies need to find a balance between *centralized* planning of priorities and policy goals, and *decentralized* management and implementation of specific programs and measure to allow sufficient flexibility and space for learning given the uncertainty of technological development and diffusion trajectories (especially given the competing pull factors of different global value chains). Further, Breznitz and Ornston (2013), who analyze the evolution of the Israeli and Finnish innovation policies, argue that *peripheral Schumpeterian agencies* may be the sources of such flexibility and learning, or for *policy innovations* necessary for promoting *rapid innovation-based competition*, given that these agencies have sufficient *managerial capacities* (or, slack). Arguably, the peripheral status (and little prestige and resources) is important to reduce the likelihood of political interference and to allow space and to create organizational need for *policy experimentation* (and innovation), but also for new forms of public-private interactions (while avoiding capture by special interests), as these agencies are unable to tap into existing political, financial and institutional resources.

This current critique of the earlier argument of the developmental state research tallies also somewhat with findings in public management research that autonomous agencies with large managerial autonomy combined with strict performance controls – in another words, new public

management style agencies emerging in the 1990s – generate a rather innovation-oriented culture (Wynen et al. 2013). Thus, also in the context of public sector innovations, we see a somewhat similar trend to move beyond the so called Weberian rational expert bureaucracies whereby organizations tasked with innovating within public organizations or services (innovation or design labs, ilabs in short) tend to be established as at arm's length institutions, with low budgets and political profiles, but with highly charismatic leaders, broad independence in agenda setting and with high level of experimentation (see Puttick et al. 2014, Tönurist et al. 2015).

In sum, while developmental state research can be described to have a 'Weberian' bias, then the more recent innovation research seems to move towards 'Schumpeterian' bias. Although, a more correct assessment would be that developmental state research has had a bias towards 'rational' bureaucratic organizations whereas more recent innovation policy research seems to have a 'entrepreneurial' or 'charismatic' bias. Still, both approaches show some evolutionary insights. The capacities for innovation of the developmental state emerge from the complicate systemic relations (often conceptualized as 'embedded autonomy' – Evans 1995) between the rational-Weberian type policy organization (with its specific organizational routines), its relations with political system (providing strategic direction and autonomy for the bureaucracy) and business system (providing input and feedback to policies). Yet, already they early critics of the approach argued that this is a very fragile institutional setting prone to politicization, capture by business sector, or dominance of instrumental goals of the bureaucratic organizations. Breznitz and Ornston (2013) recognize that also the Schumpeterian organizations may easily (often due to their success) become more 'central' and politicized as politicians either get interested in them and try to capture and gain politically from their legitimacy, or simply give them too many tasks.

While building a more evolutionary theory of how different types of organization in innovation bureaucracy emerge and evolve is a fruitful avenue for further research (see also Karo and Kattel 2014, 2015), this is not our goal in this paper. Suffice here only to mention that we assume that the driving forces of the evolution of innovation bureaucracies are often conflictual (different expectations) leading to *punctuated positive feedback processes* in public sector (see more in Karo and Kattel 2014, 2015). This explain why policy rhetoric tends to spread faster than policy practices (see Pollitt 2001), why the convergence and spread of political/institutional blueprints is often slower than that of technological (Kogut, 1991), and more generally why differences in social systems of innovation and production may persist even in times of globalizations and global value chains (Amable 2000).

In this paper, we focus on another weakness of the current debates. As seen above, these debates on innovation bureaucracies tends to narrow down from system level analysis (where evolutionary theories could be developed further) to analysis of single organizations: crucial innovation agencies are either rational in the Weberian sense or entrepreneurial/charismatic in the Schumpeterian/Weberian sense. Yet, if we look carefully at the empirical foundations of these arguments, we can notice that the abovementioned studies do not define what an innovation or developmental *agency* (the core bureaucratic entity analyzed and used as explanatory factor) actually is. Johnson (1982) looked at a *ministry*; later analyses of South Korea and Taiwan have emphasized *planning and policy coordination boards* (Cheng et al. 1998), often set up on purpose *outside* usual career system and examinations. Evans and Rauch's study (1999) does not differentiate systematically between ministries, development boards and other government organizations (nor does it in fact contain any questions about institutional or organizational structures and capacities). Neo-developmental state research has looked at a *research funding agency* (DARPA in the US – Block 2008) and at an *industrial development agency* (IDA in Ireland – O'Riain 2004). Breznitz and Ornston (2013) looked at a *ministerial department, or office* (Office of Chief Scientist in Israel) and a *foundation* supervised by a central bank and later by parliament (Sitra in Finland). These organizations have highly diverse tasks and positions within the broader governance and innovation systems; they differ in structure, size, skill-sets etc. Thus, it seems that the selection of these agencies as cases to be analyzed (and used as crucial explanatory factors) is determined by their importance as *change agents* within specific innovation bureaucracies and systems with specific bottlenecks and failures that these agents have helped to overcome (either in innovations within government or in markets). In other words, their definition and selection as crucial innovation agencies is determined by their contribution to the *system or overall policy performance*.

In essence, we have two different conjectures stemming from research in two different contexts: first, Schumpeterian-entrepreneurial characteristics of agencies (often with peripheral status) allow for internal experimentation and design of new policy approaches in the context of uncertainty of innovation and development (innovations *in* policy); second, Weberian-rational characteristics of agencies (often with central status) provide policy space and access to policy resources to actually implement innovation policies (also new innovative instruments and institutions) in a systemic way. Still, these streams of research do not provide an organizational level framework to study innovation bureaucracies as systems of organizations that exist in reality, their specific organizational routines and resulting capacities. There is scant theoretical and systemic empirical

research on how do different countries combine into single or multiple organizations different capacities for innovations *in* policy and innovations *through* policy.

2. Organizational variety and taxonomy of organizational configurations in innovation bureaucracy

It seems that for analyzing innovation bureaucracies, Weber's work is in fact much more insightful than Schumpeter's: Weber's taxonomy of domination or power (traditional, charismatic, rational) and corresponding organizational forms offers a way to describe what Schumpeter attempted to show in an analytical way. That is, Weber offers *theoretical* reasons why different types of innovation bureaucracies can deliver different policy goals and especially *how*. In essence, we can argue that in the history of innovation bureaucracy (see more in Karo and Kattel 2015) we can detect two ideal-typical Weberian organizations and evolutionary patterns in the organizational forms.

- *First*, historically most organizations of innovation bureaucracy (and new tasks it carries out) start as one type of Weberian organizations – what we can call Weber I: charismatic, dynamic organizations³ innovating often in emerging policy areas proposing new policies and regulations, standards, or cooperation forms, and reside often outside of typical government operations (but can have high level political support or enjoy societal prestige), even in private sector, or voluntary societal sphere (e.g., in NGOs, lobby groups, industry associations).
- *Second*, with time these organizations (or tasks) move (or 'grow') into another type of Weberian organization – what we can call Weber II: professional (manned with high level experts whose careers are nurtured) and centrally governed organizations that provide stability and predictability and are good at supporting (steering) innovations in markets during rather stable conditions of technological maturity, or catching-up periods (i.e. the instrumental performance of these organizations is related to long time horizons, predictability and efficiency that allows for patient regulation and public investment in long-term and complex activities necessary for technological learning and/or catching-up).

³ This form is succinctly summarized by Samier: '*A charismatic organization is consistent with its own principles, that is a new organization with its own language, mores, myths, and roles derived from the personality and belief system of the charismatic founder, affecting staffing, working patterns, social behavior, and the material environment.*' (2005, 71)

- *Third*, with the emergence of new functions (i.e. market or technological condition change and create the need for new government actions) and/or ideologies that compete with existing organizations and tasks, these organizations can be pushed towards more charismatic forms again (often under the pretense of market-friendly ideology while the instrumental performance of these organizations focuses on change, breaking existing routines that have become obsolete – e.g. the market has found efficiencies in these processes and taken them over – or that inhibit private experimentation with new products, services, marketing or other methods). This evolutionary pattern should be visible both in the case of *traditional* innovation policy (supporting firms and industries) and also in the cases of government-led *missionary* or societal challenges oriented innovations where the governments have even more central roles, i.e. innovations *in* and *through* government may be much closer and where private sector may be incentives to follow public sector interests and needs (for example in case of military technologies – Weiss 2014; or, innovations in public service delivery such as e-governance – Dunleavy et al. 2006).

While this dichotomy and the evolutionary pattern seems to give us an easy way to differentiate between organizations dealing with innovations in and through government, it seems too linear to assume that organizations – or even policy arenas, let alone countries – move from Weber I to II and back. Indeed, as we aim to show, there is potentially a more complex organizational variety of hybrids beneath the Weberian dichotomy. We use Mintzberg to unlock this diversity. Mintzberg (1989) differentiates between five key organizational configurations – *entrepreneurial, machine bureaucracy, diversified, professional, innovative* organizations – that can co-exist and exhibit – depending on the contextual factors – either tendencies for *cooperation* (through common ideology and missions), or *competition* (intra- and inter-organizational politics). He recognizes that almost all organizational configurations may be also present in the public sector (most commonly, though, machine bureaucratic, diversified and professional configurations). Crucially, he acknowledges that different organizational configurations embody different routines and capacities, i.e.: *'The entrepreneurial organization can certainly innovate, but in relatively simple ways. The machine and professional organizations are performance, not problem-solving types, designed to perfect standardized programs, not to invent new ones. And although the diversified organization resolves some problems of strategic inflexibility found in machine organizations, as noted earlier it too is not a true innovator.'* (Mintzberg 1989: 198)

Mintzberg (1989) looks at these configurations also from the perspective of organizational *life cycle*: organizations emerge in the entrepreneurial configuration and grow to other forms until potentially declining through political forces; and organizations can make good or bad internal choices on their configurations while being also affected by the feedback from external environment (competition, emulation, regulation etc), technologies, and other sources. Furthermore, the shifts in organizational configurations are not only automatic, or evolutionary life-cycle like, but may also result from conscious *design choices* (both in public and private sector).⁴

As argued, in public sector context such feedback linkages are different (and often more complex) than in markets leading to punctuated positive feedback processes (see more in Karo and Kattel 2015). Thus, we can also assume that forces of *isomorphism* are quite strong within one country, for instance because of common legal background (e.g., civil service law), universalistic regulations and rules (e.g., procurement rules) and common principles of funding (e.g. annual budgets, fiscal rules). In other words, *path dependencies* in organizational morphology and capacities tend to be relatively strong. We can build (Table 1) a more elaborate analytical taxonomy that combines two aspects of the organizational variety: organizational configurations and their specific routines and capacities (we have extended Mintzberg's framework by adding specific organizational routines that are considered as the most important in the functioning of public sector organizations; see Pollitt and Bouckaert 2011).

⁴ For example, innovative (and to lesser extent entrepreneurial) configurations – being most flexible and ad hoc – can be linked or integrated (temporarily and before they become assimilated) into different organizational configurations. Machine bureaucracies where policy and implementation are often separated can be (temporarily) made more dynamic by shifting roles, i.e. policy formulators implement and implementers formulate policies. The same way innovative configurations can be made to work on behalf of other organization, or policy domains i.e., operating adhocracies (or operating innovative configurations) concentrate on 'contract' project work while administrative adhocracies (or administrative innovative configurations) work for own internal projects/goals. (Mintzberg 1989)

Table 1. Taxonomy of organizational variety and capacities

	Entrepreneurial	Machine	Diversified	Professional	Innovative
Organizational routines	Simple; informal; flexible; little staff or middle-level hierarchy	Centralized bureaucracy; formalized; specialized work, division of labor	'Divisions' loosely coupled together under headquarter	Bureaucratic, decentralized; pigeonholes' for professional autonomy	Fluid, organic, selectively decentralized 'adhocracy' (multidisciplinary task forces)
Strategic management routines	Visionary, flexible, leadership based	Planning that is strategic programming	'Corporate' portfolio strategy and divisions with individual strategies	Stable and also many fragmented strategies by professional judgment and collective choice	Largely emergent, evolving through a variety of bottom-up processes
Personnel management routines	Limited personnel, no systemic routines, needs based development	Standardized work and skills and recruitment processes	Divided between headquarter and autonomous divisions	Dependent on training to standardize the skills of its professionals	Variety and mix of skills, openness to learning and experimentation
Financial management routines	Flexible; emergent	Efficiency and process oriented	Autonomous divisions, output oriented	Mixed; based on professional autonomy	Flexible, not efficiency oriented
Coordination routines	Direct supervision	Standardization of work processes	Standardization of outputs	Standardization of skills	Mutual adjustment
Location in the broader system of organizations	Peripheral or within machine and/or diversified organizations	Central policy implementation units with public accountability	Central/core policy units (whole policy fields)	Specialized service providers (between core and periphery)	Peripheral or in new domains, or as parts of machine/diversified organizations
Capacities	Simple/initial developments and changes	Efficiency, transparency, accountability	Concentration of different focuses	Professional proficiency	Learning and complex innovations
Trade-offs	Responsive, with mission VS vulnerable, restrictive, unstable	Efficient, reliable VS obsession with control, no initiative, autonomy	Autonomy, diversity VS costly, reluctance to innovate, requires measurable goals	Democracy, autonomy VS professional discretion, reluctance to innovate (unless collective action)	Innovative, effective VS inefficient (communication, coordination)

Source: Authors, elaborated based on Mintzberg (1989).

Thus, we propose – at this stage as an exploratory conjecture – that *organizational variety* of innovation bureaucracies as a proxy for the variety of routines and capacities is a crucial element that is often overlooked in the current innovation policy debates. Yet, given given the punctuated positive feedback processes in the public sector, it is by no means secure that organizational variety and the diverse capacities necessary for supporting innovation exist as concepts such as 'good governance' in development policy and 'new public management' in public administration often propose universal governance principles for all organizations and

bureaucracies as a whole. For the same reason, it is by no means secure that if organizational variety exists, it is compatible with the specific technological, or market context.

3. Stylized case studies of organizational variety

In the following section we will look at the existing literature on innovation bureaucracies in three critical cases that offer also contextual variety (in terms of polity types, development levels, country size): US as the most discussed case in innovation policy research, Finland as an example of European innovation policies (and a critical case in the peripheral/Schumpeterian agency argument), and Taiwan from East Asia. With our stylized case studies we try to illustrate how our perspective on organizational variety and the taxonomy provided may help to systemize and synthesize the current theoretical and policy debates around organizing innovation bureaucracies.

3.1. The hidden, but mighty US innovation bureaucracy

US is probably the most researched innovation system and polity in the world, and frameworks seeking broader applications need to almost by necessity discuss the case. When discussing the success of US innovation system and policies since the post WWII and especially since the 1980s, different explanatory frameworks emphasize individual level policy entrepreneurship (e.g. Leyden and Link 2015), specific organizational context of key public and private R&D organizations as sources of innovation (e.g. Augier et al. 2015; Bonvillian and van Atta 2011), and also the specific nature of the US national, regional and sectoral systems of innovation.

Whether one sense behind the evolution of the US innovation system the broader *military-defensive imperatives* and politics (Weiss 2014), or the more traditional *politico-administrative compromises* and institutional 'engineering' (Block 2008; Block and Keller 2011) where also single individuals could trigger important changes (Leyden and Link 2015), it seems that different frameworks would agree with the interpretation that the US post-WWII supremacy in almost all fields of technological innovation has been significantly dependent, on a *hybridized cooperation* between: a) *high-tech oriented private sector* (since the the 1960s-1970s, US defense and innovation policy has shifted away from the tradition of having large defense contractors as key procurement partners), b) rather *hidden and decentralized system of federal agencies, programs* and government backed firms (such as In-Q-Tel) experimenting with different technologies and pro-actively combining national defensive needs and technological diffusion and adoption across industries (see also Keller and Block 2012),

and c) the long-term oriented regulatory, financial, scientific (R&D) setting provided by the core government organizations and policies (see, e.g. Mowery et al. 2010; Foray et al. 2012).

While the institutional landscape of innovation has been rather diverse across key technological sectors (defense, health, energy), Weiss (2014) argues that all of them have contributed to national defense goals, or missions. At the same time, there is no clear consensus on the sources of the policy capacity to steer the developments in these sectors. While Block (2008) argues that most of the US industrial and innovation policies has been institutionally *hidden* (i.e. in small agencies and programs, such as SBIR) from the congressional politics and public debate *allowing* different elements of the bureaucracy to *gain autonomy* in adverse political setting (see also Fuchs 2009), Weiss (2014) emphasizes that the institutional model has been in fact centered around presidential control and *steering* (supported by the Oval Office and the *Office of Science and Technology*) and also in the more specific narrative of maintaining national defense via technological superiority. Regardless of the precise logic, this *bureaucratic autonomy* seems to be rather extensive and it has allowed to establish a extremely close interactions between the bureaucracy and the private sphere described by Weiss (2014) as *governed independence* creating world-leading trajectories of dual-use technologies and technology transfer (Mazzucato 2013).

Thus, one can argue that the key public institutions of the US innovation system have been *core federal departments* contributing directly or indirectly to the defense goals (from defense to health and energy, i.e. DoD, NIH, DoE) and their *networks of agencies* (e.g., NASA, CIA, Office of Naval Research, DARPA, NSF) and *federal laboratories* created for implementing policy through the hybrid networks between public and private actors (to steer private R&D, negotiate support and leverage resources for state-directed defense-oriented projects). While the federal agencies and laboratories might be picked out and treated as unique/peripheral agencies, in our framework, these agencies should be treated as crucial *change agents* within a broader machinery of government that contributes to the policy goals as a whole. How these agencies are set-up and managed depends largely on their policy context and mission (i.e., some agencies might emerge as more bottom-up initiatives and in peripheral state while others might be created in a more top-down manner with more explicit goals and missions to disrupt existing *status quo*).

In other words, looking at the organizational configurations and institutional setting of the innovation system, there indeed seems to be a combination of dual mix of routines behind the government departments and

agencies. *Core federal departments*, especially related to military, seem to follow their own specific and mostly hierarchical (military) planning, command and coordination patterns (similar to Weberian expert/professional bureaucracies). At the same time, the *network of agencies and laboratories* seems to follow much more diverse sets of organizational routines.

In this system, the key agency has been the *Advanced Research Projects Agency* (ARPA) founded in 1958 under President Eisenhower in response to the Sputnik shock as a relatively small (originally receiving 4% of military's R&D budget; currently about 3 billion USD) and autonomous federal R&D agency (with the mandate to create and prevent technological surprise and deal with the 'presidential' issues of space, missile defense and nuclear test detection) under the Secretary of Defense reporting to the Director of Defense Research and Engineering who became with the 1958 Defense Reorganization Act the chief technologist of DoD (Van Atta 2007). From the outset it was allowed to collaborate with the commercial industry in developing both military and dual-use technologies. It was renamed from ARPA to a more specific defense-oriented DARPA in 1972 (with transfer of non-military R&D activities to civilian agencies and clear specialization on military issues) as a reaction to the criticism of defense and military dominance of (and its potential distorting effects on) the US economy. Compared to core federal departments, DARPA has followed a much more specific mix of organizational routines to achieve its missions. While the expectations on DARPA have changed over the years and so have some of its institutional elements, there have been also common routines over time (see Bonvillian and van Atta 2011) making DARPA rather similar to the innovative configuration of our framework:

- It has followed a rather *entrepreneurial managerial approach* with short-term (3-5 years) appointment of highly capable program managers (with proven technology-related track-record in military, academia, or industry, i.e. based on merit and not seniority or other criteria) who act like *experts-on-loan to the bureaucracy* (mid-level people whether from the government, industry or academia who are temporarily on a leave from their permanent position – Fuchs 2009: 67) with budgetary autonomy to steer the direction of the funded R&D projects (indeed, it has worked as a project-based organization with some missions, or technological priorities)⁵;

⁵ In 2013, DARPA's budget was about \$3 billion, it had 210 employees, approximately 250 programs running in seven technology offices and total number of contracts, grants and other agreements exceeding 2000 (DARPA 2013). DARPA's technical staff consists of program managers, deputy program managers, office directors, deputy office directors, directors and deputy directors, in numbers about 120 people every year. Annual personnel turnover rate usually stays around 25% (Carleton 2011).

- These program managers are assessed internally through *personal feedback and peer pressure* as opposed to formal performance management and incentive systems. The Office Directors and the Director of DARPA approve the programs while following The *Heilmeier Catechism*, review the progress and make sure that the programs are scrutinized (Jordan and Koinis 2013). This system seems to also allow for failures and closure or changes of non-working projects and initiatives;
- As mentioned, it's *legitimacy* has been based on the national defense narrative and guarded by the DoD leadership that does not intervene in specific projects, but has from time to time influenced the larger missions.
- Internally, it has used rather *streamlined organizational and managerial processes* as project approvals that rely on in-house expertise as opposed to peer-review.

Over the years, DARPA's programs and funding choices (it does no internal R&D) have contributed considerably (together with other agencies and programs) into most defensive and civilian innovations (see Mazzucato 2013) and the organizational model has become a blueprint for systemic changes and innovations in other policy fields, from homeland security (HSARPA in 2003), intelligence (I-ARPA 2007), and energy (ARPA-E in 2009). Yet, the differences of technology fields and policy domains seem to make the landscape of agencies much more diverse than that of the core departments. It is well documented and NIH in the area of health and NSF as generic R&D funding agency combine centralized expert skills with in-sourced field-specific skills in the form of medical- and academic self-steering through mechanism such as peer-review (see e.g. Sampat 2012). From this perspective, they are closer to professional than innovative configurations. Further, Bonvillian and van Atta (2011) show that even if ARPA-E in the energy sector has been benchmarked based on DARPA, the fact that it functions in the *complex established legacy sector* has required its own institutional adaptations (i.e. both are closer to innovative configurations, but focus on different sub-routines and ways of standardization and coordination):

- Most importantly, as it functions more as a civilian agency created only recently, it has needed to *build its own legitimacy*. This has been achieved through support of leading politicians (i.e. Energy Secretary Steven Chu was one of the original proponents of ARPA-E while serving on the National Academies' Gathering Storm report) and selection of directors with internal, or external legitimacy (i.e. first director Dr. Arun Majumdar had strong track-record in industry, academia and VC, second director Dr. Cheryl Martin has a strong background in Silicon Valley VC industry).

- Further, though bi-annual energy summits and high-level publicity work it seeks to move from a visibly small peripheral agency (with budget around \$200-400 million in different years) to a *visible innovation driver* (i.e. show-casing civilian achievements – i.e. funding the recent developments of Tesla Motors to offset the high-risk and politically sensitive failures such as Solyndra) and a necessary *systemic change agent* in the regular DoE R&D bureaucracy (Office of Science, other applied agencies) as an integrator or accelerator of the diffusion of its R&D.
- Its internal *routines* are similar to DARPA (e.g. fixed 3 year contracts for autonomous program managers), but its smallness allows for even flatter organization (director and program managers and no office directors) with *person-based internal coordination, communication, feedback and performance assessment*.
- At the same time, it has needed to build somewhat different *pro-active external coordination skills* as there is no defense-like demand for technological diffusion (and also central control and coordination of the DoE agency system) and CELS characteristics require more emphasis on supporting diffusion (i.e. ARPA-E has its own technology to market team), technological demonstration etc. For this kind of skill development, ARPA-E uses both *external advisory networks* (i.e. ‘wise men’ similar to DoD JASONS) and *internal skills development initiatives* (i.e. fellows program for recent PhDs).

Overall, the specific organizational routines – closer to innovative configurations with missionary forces – have allowed agencies such as DARPA and ARPA-E to both be free of traditional bureaucratic constraints, but also take-on riskier projects and R&D directions that the private sector would be unwilling to undertake (Mazzucato 2013). In our interpretation these agencies have worked as a *coordinating change agents* within the broader sectoral innovation systems identifying and bringing together potentially important people and ideas from academia, business and government and providing early financial incentives while the *substantive impact* of their work – in terms of adoption and diffusion of new innovations – is as much dependent on both the private sector capacities to cooperate in the innovative projects and on the machine bureaucratic core departments of military, health and energy policy who are able and capable through procurements, regulations, subsidies either purchase or influence the adoption and diffusion of specific innovations with socio-economic relevance and impact.

3.2. European innovation states: the case of Finland

The European landscape of polities and innovation systems is highly diverse (see e.g. Amable 2000). At least until the demise of Nokia, the Finnish catching-up and growth pattern since the 1990s was one of the clear success cases in Europe. Ornston (2012) argues that the 1990s-2000s Finnish growth miracle grew out from previous era of state-led development (based on state-owned enterprises, credit rationing, price-fixing cartels, competitive devaluation etc – in other words, a variety of different organizations and policies) and creation of specific form of corporatism (more state- and firm-centered than labor-centered). This development path had established specific policy legacies – preference given to establish firms in capital-intensive resource-extractive industries and metal-based engineering – supported by state institutions with strong financial and monetary planning and public-private negotiation/cooperation routines. The close integration with and subsequent fragilities of dependence on Soviet Union triggered since the 1970s gradual, but important policy and industrial changes that shifted old corporatist routines and institutions towards so-called *creative capitalism* (since the 1980s) that emphasizes R&D, human capital development and new modes of finance (public sector initiated VC-industry etc) as drivers of economic change. Thus, the 1990s Finnish economic reinvigoration was based on R&D-centered policy model centered on public-private and inter-firm R&D collaboration (ICT cluster in general, NMT/GSM standards) initiated by the peak-level bipartite and tripartite agreements. The key public institutions (in addition to traditional ministries) driving this policy model, relying also on postwar practices of business-state cooperation, have been:

- The bi-partite Science Policy Council that was converted into tripartite *Science and Technology Policy Council* in 1987 as the arena for national developmental agreements to promote investment in R&D and innovation (i.e. these high-level corporatist networks have allowed, according to Ornston 2012, to agree upon important shifts in development orientation; for example, cutting some parts of public sector expenditure while increasing especially applied R&D expenditure, bringing national pension funds to invest in new economic spheres where regular banking would not enter);
- *Government agencies*, most importantly Sitra (created in 1968⁶) and TEKES (The Finnish Funding Agency for Technology and

⁶ Sitra is a Finnish acronym for 'A jubilee fund to celebrate the independence of Finland'. (Ahlqvist 2013). It is considered to be a key independent intermediary policy implementation organisation in Finland whose one of the main objectives is turning R&D projects into business plans. (Tuunainen 2011).

Innovation created in 1983 after parliamentary Technology Policy committee recommendations in 1979) to implemented developmental agreements and lead the R&D efforts (i.e. by VTT);

- Other agencies contributing to the emergence of creative corporatism have been the Sponsor foundation in the 1950s, regional foundation KERA and Finnish Industry Investment in the 1990s (latter two provided SME financing during the 1990s crisis), and also SME Foundation, The Foundation for Finnish Inventions, Finnvera, and The Regional Council of Northern Savo (see more in Varis and Littunen 2010).

Especially the creation of TEKES initiated public-private R&D networks as industrial cooperation was pivotal for its role as a *non-targeting and non-vertical innovation funding agency*. In principle, TEKES has financed all the most important companies in Finland and has incentivized their collaboration with universities, R&D agencies (such as VTT) and also obliged collaboration between large enterprises and SME. Prior to TEKES, Sitra had acted as the funder of new and emerging companies via grants. In 1980s a new division emerged with Sitra providing loans to companies in early stages risk-capital markets (establishing the Finnish VC market and the Finnish Venture Capital Association in 1990) and TEKES (who had considerably larger budget) concentrating on R&D funding and incentivizing the above-mentioned R&D networks. These agencies worked in complementary manner as almost all companies receiving Sitra's financing received also TEKES grants for technological innovation (Ornston 2012). With the maturation of the private VC industry, in 1991 Sitra was transferred from an Central Bank supervised agency into an *independent policy foundation* under the Finnish Parliament (OECD 2006) and also started to address 'softer' capabilities of marketing, management, social innovation etc (Ahlquist and Moisio 2014).

Overall, compared to the US, the Finnish innovation policy has been driven by much more explicit political consensus (supported by the corporatist tradition of informal negotiations and coordination) leading to specific missions and directions for different organizations. In this context, the key agencies such as Tekes and Sitra have worked as complementary change agents with shifting division of labor and also evolving organizational routines. While Breznitz and Ornston (2013) argue that the Finnish public administration system has followed visible Weberian patterns (in the sense of professional expert organizations), Pollitt and Bouckaert (2011) trace the gradual emergence of more fluid bureaucracy. For example, similarly to the border changes in the governance system, Sitra: a) does not belong officially to any government sectors, b) is free to organize its structure (in 2012 it shifted from fixed-term program struc-

ture to project and theme based matrix model) and skills-set (it employs around 100-120 workers with 40-50% of people on fixed-term contracts), c) is funded mostly through its owned endowment, d) is free in its investment decisions (approved either internally or by its Board of Directors depending on the size of investment) and policy focuses (setting up projects, designing policy processes, publishing reports etc). These seem to be clearly elements of an innovative organizational configuration. At the same time, Breznitz and Ornston (2013) argue that the parliamentary supervision has increased the politicization of Sitra.

In sum, as in the case US, it seems that the innovation system is comprised of both classic hierarchical professional and more innovative organizations with shifting divisions of labor coordinated by the high-level agents for corporatist agreements. Ornston (2012) has recently argued that this system has had a tendency to create policies and activities centering mostly on *technological innovation* and giving less emphasis on non-technological innovation, re-training of work-force, design skills etc. Yet, as opposed to the case of US, where the role of the state in innovation is politically often criticized and innovation policy is often hidden from the public view, the Finnish system, is able (although, arguably with some delays) to trigger through high-level political agreements more systemic experimental initiatives in governance (see Annala et al. 2015). Overall, the differences on how organizational variety has evolved in US (engineered and forged through despite political criticism and legitimized via national defense narrative) vs Finland (through corporatist and consensual high-level agreements and coordination) illustrate the broader differences of economic policy-making in more liberal/simple vs coordinated/compound polities (Schmidt 2004). Yet, both varieties of polities show how systemic view of organizational variety helps to combine the arguments of state- vs market-based development and Weberian vs Scumpeterian/peripheral organizational routines into a common framework.

3.3. East Asian innovation states: the case of Taiwan

As was discussed above, East Asian economies (from Japan to South Korea, Taiwan and Singapore) were once linked even strongly with state-led development than Finland. By now, most scholars emphasize a more networked modes of governance where the role of government has shifted (again, with some difficulties in most cases) from trying to control, manage and steer the private sector to fostering interactions, networks and collective action between different actors (e.g. Noble 1998; Wong 2011; Yeung 2013). Out of the East Asian cases, Taiwan is to date the most statist and Confucian in its development model (see Drechsler and Karo 2016).

While Taiwan is extensively discussed in the literature on developmental state, agencies and bureaucracy in general, it is in fact highly difficult to define agencies that are comparable to Western cases. While Taiwanese societal and economic development has been (since 1949) clearly stated, following Confucian principles (protected by separate standing of the Examination Yuan) – that resemble to Weberian interpretations of bureaucracy – and rather stable administrative organization of the Executive Yuan (see Sun 2002; Wang and Shih 2011; Shih et al. 2012), we can argue that in development and innovation policy there have been distinct periods following different institutional logics.

From 1949 to mid-1970s, Taiwan (ruled by Chiang Kai-shek) followed industrial catch-up strategy with limited R&D and innovation policies and based on conflicting institutional characteristics. Taiwan was a divided society where native Taiwanese were largely excluded from politics and bureaucracy (both followed KMT party lines); local economic agents received almost no attention and support from the government who implemented industrial policies via state-owned enterprises and selected large enterprises. Thus, while politico-administrative relations seemed institutionally rather stable and Confucian, Wu (2004) claims that these ties were highly distorted towards political control and personal relationships between the rules and key bureaucrats. During this period, the US aid based *economic planning agencies* – Industrial Development Council (IDC, 1953–58), Economic Development Board (EDB, 1953–58), Council for US Aid (CUSA, 1959–63) and Council for International Economic Cooperation and Development (CIECD, 1963–73) – where the key policy institutions. These provided policy input for regular ministries of finance and industry. Cheng et al. (1998) show that these agencies were constructed outside the normal bureaucracy to have flexible coordinating roles and allow for less strict bureaucratic rules (higher salaries, flexible recruitment etc) and more autonomy. Wu (2004) claims that their short life span (as they were mostly abolished by political choices of the ruling elite) is indicative of their dependence on the policy and person-based relations with the ruling elite; and the elite had much closer personal ties and trust in the financial as opposed to economic planning bureaucracy. Further, the general political ideology limited the government-business relation largely to the state-owned enterprises sector, or government-imposed steering as opposed to mutual feedback.

The growing political isolation of Taiwan in the 1970s and economic pressures of catching-up increased the need for more conscious upgrading-oriented industrial and innovation policy. This resulted in the 1979 Science and Technology Development Program and related institutional developments and a new era of the Taiwanese developmental state (see

also Hsu and Chiang 2001). The new ruler (Chiang Ching-kuo) preferred more direct steering of the daily affairs of the bureaucracy (Wu 2004). Many policy tasks were gradually centralized over the 1970s-1980s from the rather ad-hoc US-aid based agencies into the *core Executive Yuan bureaucracy* (comprising of Executive Yuan level committees and more traditional agencies) (see also Cheng et al. 1998).

The impressive ICT developments in Taiwan (see Breznitz 2007) are often linked most notably *Industrial Technology Research Institute* (ITRI, created in 1973 as a merger of existing government labs). ITRI's task has been to concentrate on R&D and technological development (as state technology-creating agent acquiring and developing foreign technologies, diffusing them to industry and supporting private R&D and development activities) to the extent of providing prototypes that can be transferred to the private sector.⁷ Thus, it is mostly a research institute carrying out tasks that are in other countries found in public and private R&D institutions usually not discussed as developmental/innovation agencies. At the same time, its activities were the core tasks of policy implementation in a statist developmental state model. Looking at more traditional governance organizations, the *Department of Industrial Technology* (DoIT) of the Ministry of Economy was created in 1979 as the Science and Technology Advisory Office (and minister-led advisory group) seeking to shift the developmental state's orientation (together with *Industrial Development Bureau*, IDB) from industrial catch-up to innovation policy (it became DoIT in 1993). It has mostly planned and financed R&D activities of government research organizations such as ITRI (since late 1990 it has also entered into financing industrial and academic R&D that make up ca 20% of total funding) (see also Hsu and Chiang 2001; Jan and Chen 2006). These developments established new types of organizational routines driving the policies behind the ICT development in Taiwan:

- Taiwanese core bureaucracy has differed from most other countries because of its combination of Confucian values and administrative principles and emphasis on bringing *engineering skills* (as opposed to generic skills in administration, business, law etc.) to government. Thus, industrial research agencies such as ITRI have been 'enabled' to carry out its rather active and interventionist roles by the *engineering-driven expert policy bureaucracies* of DoIT and also IDB. Thus, also the latter more traditional professional and hierarchical organizations should be considered – at

⁷ According to Breznitz (2007), ITRI is recognized (even by business leaders) as the only R&D performing institution in ICT sector concentrating on hardware. Yet, similar institute in software development – Institute for Information Industry – is considered as failure as it rather competes than complement private sector investments (see also Noble 1998).

least from policy making perspective – as central professional agencies steering the activities within the innovation system;

- As a result, innovation policy planning has been both highly detailed and *expertise-based* (in terms of technologies to be developed for the market in public agencies using public finances) and *centralized to core bureaucracy* of to the Executive Yuan and even to the level ministerial choices and decisions (ITRI has negotiated with ministerial bureaucracy; strategic technological choices are decided and supported by ministers);⁸
- Engineering and industrial expertise has allowed for *state-led interaction with private business* (as the latter have limited access to finance and depend also in their capability development on governmental and ITRI's R&D choices and direct financing) and strategic and specialized attraction of MNCs with conscious goals for technology and skills spillovers.

Breznitz (2007) argues that these routines have enabled Taiwan to excel in hardware-related and original-equipment-manufacturing and original-design-manufacturing sectors of ICT (see also Amsden and Chu 2003), but less in software development as the technological specificities might require different policy perspectives and feedback interactions. Since the democratization in late 1980s, there has been another pattern of institutional developments. On the one hand, public administration research indicates that there has been little institutional change (at least until the 2010s when significant reforms were initiated following the US and Western logic of administrative development) (see Sun 2002; Wang and Shih 2011; Shih et al. 2012). The bureaucracy was at least in 1990s still strongly linked with KTM ideology and to date most policy bureaucracy seems to have strong engineering background. On the other hand, the role of industry and private sector has gradually increased in STI policy. Since the late 1990s, DoIT has started to directly finance industrial R&D and public-private joint R&D projects and the role of ITRI has become *more networked* within the innovation systems (as a consultant and trainer of private agents) (for overviews, see Hsu and Chiang 2001; Jan and Chen 2006; Wu 2007). Studies of the emergence of biotechnology as a government strategic policy field (Wong 2004; 2011; Chung 2013) show that over time the central logic of industrial policy has become more fragmented and potentially less efficient. Indeed, biotechnology was raised as national goal already in 1980s, but it has received clear policy

⁸ Wu (2004) claims that this has resulted from the combination of the institutional set-up, personal skills and roles of key political and bureaucratic leaders (i.e. the role of Kuo-Ting Li in the Taiwanese development as both minister of economy and finance in the 1960s-1970s – see Li 1995), and the paternalistic culture of the Confucian Taiwan legitimizing state-led industrial planning and thinking (i.e. via high-level national conferences etc).

support only since 2000s with many fragmented activities between different ministries and agencies (for detailed analysis, see Chung 2013). Alternatively, this could be also treated as normal 'search' for new policy models and organizational morphologies given the new feedback context.

Overall, we see again a rather distinct politico-economic and politico-administrative context into which a variety of organizational configurations has gradually evolved (see also Liu and Wen 2012). Pinpointing a single organization as the crucial success factor of innovation policy seems to be a too crude simplification of the institutional context and organizational variety.

4. Conclusion

In this paper we have shown that the debates on how to organize public sector activities to support innovation in policies and through policies in markets have over-concentrated on single-organization research and single-variable explanations: central, hierarchical and professional vs flexible decentralized/peripheral organizations are key to effective innovation policies. Yet, the three stylized cases reviewed show that modern innovation policy is designed and implemented through much more varied organizational morphologies. Thus, instead of single-variable explanations and silver-bullet-like policy recommendations on how to organize government actions to support innovation, we might gain greater understanding of these questions by focusing on organizational morphologies and their comparative and internal variety in innovation policy design, implementation, evaluation and learning. Our three case studies provide the first insights into the following research and policy-relevant issues.

First, there indeed seems to be much stronger organizational variety within the public sector than often assumed. Even in the most statist economies (e.g. Taiwan), there is no single monolithic bureaucracy and also no single central or decentralized/peripheral organization is alone able to both come up with policy innovations and scale and diffuse these with sufficient impact on markets. Our research shows that organizational variety is perhaps important in itself, as it allows for some functions of innovation policy to be fulfilled in relative stability (e.g. basic research funding under peer-review), but in other areas more experimental solutions could be sought (e.g. active industry participation in applied research prioritization and evaluations).

Second, the organizational morphology of innovation bureaucracy varies from context to context quite remarkably and there are strong path dependencies. Thus, new policy interventions, especially if emulated from

other countries and implemented by organizations with strong institutional memories and legacies, are likely to be internalized and molded to fit with existing organizational routines. In other words, the focus of innovation policy research and policy advice should not be only on improving *policy mixes*, but it should also pay attention to the *organizational mixes* and their contextual roots. The cases seem to provide a conjecture that contextually embedded organizational variety can improve policy performance, especially if the variety provides routines and capacities for both policy innovations and efficient and systemic implementation, or policy impact. Yet, we need much more original data, research and insights both on the level single organizations (their internal routines and capacities and external feedback links) and on the level of innovation bureaucracies as systems of organizations.

Finally, there is a need for systemic research what role technology and techno-economic paradigms play in evolution of innovation bureaucracies, what are country-specific and the sectoral differences; and how does globalization of innovation and production networks, and of policies and of policy elites under WTO and multilateral agreements, influence evolution of innovation policy capacities. Broadening the understanding of the evolution of public policies and organizations in their respective techno-economic, politico-administrative and business-administrative feedback contexts, and what kinds of routines and capacities emerge from these, is a crucial academic and policy analytical tasks towards more effective innovation policies and more entrepreneurial states.

We can also argue that the critique of limited entrepreneurial capacities to increase the socio-economic impact of innovation and/or speed-up innovations and diffusion of new technologies (biotechnology, sustainable energy etc) found in both Western states (Mazzucato 2013) and also in Asia (Wong 2011; Yeung 2013) is itself a result of existing organizational morphologies and established routines: public organizations operate in their specific feedback contexts where techno-economic feedback may be punctuated by other factors. Most importantly, the common lines of development across the Western and Asian economies has been to adopt similar concepts of innovation policy (in terms of university-industry cooperation, IPR systems, R&D funding schemes and organization of public universities and research) regardless of the specific techno-economic and business-administrative contexts (or social systems of innovation and production); and also to shift towards politico-administrative and governance systems where risk taking by public organization is replaced by other routines (short-termism, cost-efficiency) not driven by the concerns of innovation and economic development.

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