



**3rd International Conference
on Public Policy (ICPP3)**
June 28-30, 2017 – Singapore

Panel T06P01

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

Innovation Bureaucracy:

**Does the organization of government matter when promoting
innovation?**

Author(s)

Rainer Kattel, Wolfgang Drechsler, Erkki Karo

All Ragnar Nurkse School of innovation and Governance, Tallinn
University of Technology, Estonia; erkki.karo@ttu.ee

Innovation Bureaucracy:

Does the organization of government matter when promoting innovation?

Abstract: Current research on how to organize the roles of government in promoting innovation converges around a rather simplified single-organization explanation: support of innovation requires either (Weberian) elite expert organizations or (Schumpeterian) fluid peripheral organizations. We show that looking at history of innovation bureaucracy, a more complex picture emerges: historically we find a rich organizational variety in how governments have organized different innovation promoting activities. We show that historically this organizational variety is, first, driven by highly diverse public-private relationships; second, the variety is of evolutionary nature; third, the diversity of organizations itself is an important factor in success and failure of innovation policies. Combining analytical lenses created by Weber and management literature on capabilities and ambidexterity, we build analytical framework to understand how organizational variety of innovation bureaucracy evolves over time. We finish with discussing the importance of organizational variety for the concept of entrepreneurial state.

Keywords: innovation, Weber, ambidexterity, public management

I Introduction

Gustav von Schmoller, leader of the ‘younger’ German historical school of economics, complained more than hundred years ago that Smithian economists assume that well functioning public bureaucracy and orderly finances are always given and that this assumption leads them to numerous mistakes (1900, 292).¹ Similarly, Richard Nelson and Sidney Winter reminded us more than 30 years ago: “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.” (1982, 384-385) Yet, most

current innovation policy² debates have one thing in common: implementation of policies is often assumed to be exogenous to policies; what matters is the policy choice (e.g., what kind of R&D tax breaks work? should we have a public venture capital fund?), and not how this choice is designed and implemented, and by whom. (See also Flanagan and Uyarra 2016) Thus, there's an inherent *policy bias* when we typically talk about innovation and the state.³ This is in quite a stark contrast to private sector innovation discourse where innovation is often related to implementation (e.g., how to explore new opportunities and at the same time keep exploiting exiting strengths; what kind of organizational capabilities lead to innovations; see Lam 2006 for an overview). Such asymmetry is also reflected in research: while studying public sector organization of innovation is relatively rare even among Schumpeterian/evolutionary economists, then studying private sector organization of innovation is a venerable field of research and teaching (we will come back to this below). This essay sets out to show that public sector organization of innovation supporting activities – implementation of various functions of innovation policies – greatly matters to society's successes and failures in trying to promote innovation and technological advance. We call these organizations *innovation bureaucracy*: public sector organizations tasked to enhance R&D, innovation and technology (via funding, regulating, procuring) – both in public and private organizations.

Probably the best illustration of modern academic thinking and policy practices on these issues is a recent paper by Breznitz and Ornston (2013). They analyze the evolution of the Israeli and Finnish innovation policies and argue that *peripheral Schumpeterian agencies* may be the sources of *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.⁴ Importantly, they claim that these findings contradict the earlier development and innovation policy research (from Johnson 1982; Wade 1990 to O’Riain 2004; Block 2008) that emphasized nodal or central pilot agencies (also referred to as *Weberian agencies*) as the source of developmental/innovation policy success or impact.⁵ Particularly East Asian *developmental state* scholars – Amsden (1989), Evans (1995; Evans and Rauch 1999), Haggard (1990), Wade (1990) – turned the concept of *highly capable bureaucracy* (together with a specific notion of embedded autonomy) into a crucial variable explaining the strong state-led development performance of East Asian economies and beyond. This line of research has *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 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. Evans and Rauch (1999) cemented these ideas through a more quantitative analysis that only tested the importance of some of the Weberian elements (merit-based recruitment and career systems) on a much broader sample of countries as a whole without explicitly looking at innovation/development agencies/bureaucracies as explicit cases (see also Rauch and Evans 2000; Evans

1998).⁶ Their findings seem to still have traction in mainstream governance research (Nistotskaya and Cingolani 2014) and entered mainstream media discussion as well (*The Economist* 2016).

Paradoxically, it is almost never explicitly defined in any of the abovementioned research what is actually an innovation or developmental agency; that is, the type of organization is not part of the discussion:

- Johnson (1982) looked at a *ministry*, later analysis 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 (1999) empirical study of 126 countries does not differentiate systematically between ministries, development boards and other government organizations.
- Neo-developmental state research has looked at a *research funding agency* (DARPA in the US – Block 2008), *industrial development agency* (IDA in Ireland – O'Riain 2004; Breznitz and Ornston 2013 argue that peripheral agencies in Ireland have been IDA's sub-divisions, i.e. subunits within an organization).
- Breznitz and Ornston (2013) look at a *ministerial department* (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 broader public management and innovation policy systems; they differ in structure, size, skill-sets

etc. For instance, a ministerial department and public (R&D) agency are even within the same country almost always rather different organizations (how and to whom they report; hiring and promotion practices, financial reporting rules are likely to be very different; etc). In sum, it seems that the selection of the abovementioned cases as crucial elements to explain innovation policy performance of different innovation systems is determined by their role as *change agents* within specific systems that have its' time and context-specific bottlenecks and failures that these agents have helped to overcome. What these organizations do, how they are set-up, and why they have been crucial change agents depend on the wider system characteristics and development.

In what follows we aim to show that both analytically and historically the diversity of innovation bureaucracy is richer (both in function – what these organizations do –, and in organizational variety, i.e. how they work as organizations) than previous research has shown. We show that the arguments in favor of central (Weberian) vs peripheral (Schumpeterian) agencies are in fact not mutually exclusive, but highlight the complexity of how government organizations need to be structured and organized (and what type of outcomes we expect from different organizations) to support innovations in firms and industries. Further, we argue that innovation bureaucracies are tasked with wide range of functions carried out by layers of different organizations. We also show that organizational change in innovation bureaucracies is cyclical: technological change generates new tasks for public organizations, often these new tasks are initially taken up by new organizational forms that later become more standardized and ‘bureaucratized’. We propose a general framework of how to understand dynamics of innovation bureaucracies, and end with a discussion of organizational variety and entrepreneurial state.

II History: how have governments organized innovation efforts in the past?

Historically, modern public organizations consciously aiming to support innovation and technological advancement emerge mostly during 19th century.⁷ It is probably not a coincidence that such organizations coalesce concomitantly with the diffusion of the industrial revolution. There are two key trends that help to explain the birth of *modern* innovation bureaucracy:

First, the emergence of polytechnics and engineering education (related to both military and civilian needs) in Europe and the US (mostly military engineering at West Point) that created supply of engineers and technicians for both public and private sectors.⁸

Second, the emergence of professional managerial class both in private companies (e.g., in railroads, armories, and others) and in public sector (e.g., military procurement practices of Quartermaster department during the US civil war).⁹

From these two springs, as it were, come forth almost all forms of modern innovation bureaucracies: it is difficult to think of any such organization without engineers (technical skills) working in them as it is equally difficult to imagine them without a professional level of (middle) managers. This would indicate that historically innovation bureaucracies resemble quite strongly the Weberian thesis proposed in 1980s and 1990s by developmental state studies: hierarchical rational (elite) expert organizations supporting mostly private sector in innovations and technological

change. However, the story is not as straightforward. In fact, while most innovation bureaucracies use technical experts/engineers and professional managers as key ingredients of their organizational DNA, the way these become fused with various technological, financial, political and administrative contexts (or feedback mechanisms) opens up a much larger and colorful canvas for organizational varieties to emerge. Indeed, as we will show, it is the relationship between private and public initiative, and how these partnerships are organized and structured, that is one of the key determinants for how types of innovation bureaucracy emerge and operate.

However, what is equally important is that the functions, or tasks, innovation bureaucracies have been carrying out since the industrial revolution, vary quite significantly in time. Innovation systems scholars (e.g. Edquist and Hommen 2009) have tried to systemize the key functions or ‘activities’ in the innovation system (recognizing that the state has a distinct role in most activities and this leads to complex policy mixes). Others have tried to operationalize these functions/activities through institutional complementarities (also between public and private sectors) of the social systems of innovation and production (Amable 2003; Hollingsworth and Boyer 1997) and argue that these institutional complementarities may be highly diverse across regions and economies. There are two common limitations in these streams of research. Firstly, they mostly have a snapshot perspective: what are the functions ‘as of now’ (in the best performing or different ideal-type systems), there is relatively little discussion of why and from where have these functions emerged from. (See also Flagan and Uyarra 2016) Secondly, there is no systematic organizational perspective on how these functions are organized (who is actually implementing given functions). It is noteworthy that innovation scholarships centres around

activities/functions and *policy mixes* (mixes of public sector activities) and *institutional complementarities* (mixes of institutions, e.g., university-industry connexions), but rarely discusses organizational mixes (or organizational varieties and complementarities).

Expanding on abovementioned innovation systems and (historical) institutionalist scholarship, and in particular on the taxonomy of “processes and institutions for policies on technological learning and industrial change” offered by Cimoli et al. (2015: 57-59), we propose in Table 1 a birds-eye view of innovation policy functions.

Table 1 describes what policy goals have been historically pursued by governments and how these goals relate to innovations and technological advance. We also add ‘original’ (organizations that emerge in the aftermath of the industrial revolution) and currently ‘dominant’ (organizations found in variety of countries) forms of organization for each function. It goes without saying that there can be considerable over-lap between functions and organizational forms; here they are depicted in an ideal-typical taxonomy.

Table 1. Taxonomy of Functions of Innovation Bureaucracies

Function	Socio-economic policy goals, relation to innovation	Original form(s) of organization, place, approximate time, area of activity	Currently dominant form(s) of organization, examples, country, area of activity
Management of strategic resources	Ensure socio-economic returns from key assets; up-/downstream skill and technology development	Private trading companies with public support, gradually nationalized (e.g., UK, NED, US). 1700s-1800s. Overseas trade, colonization, public revenue creation.	State owned companies (Petrobras, BRA, natural resource management), public holding companies (Singapore), public universities (e.g., Estonian Genome Project, genetic database management and related research).
Long-term investment	Ensure financing of future technologies and skills, upgrading of existing ones; infrastructure and	Private banks as public debt agencies (US, early 19 th c); private industrial banks under public-private central bank (GER, 1870s). Industry, public works	Public development banks (BNDES, BRA, industry, infrastructure, regional development); public-private not-for-profit venture capital partnership (In-q-tel, US, high

	public works development		tech); foreign aide organizations (World Bank, European Commission; infrastructure, regional development).
Furthering knowledge frontier	Ensure research into basic scientific questions, enable next generation of technologies	Althoff system of ministerial guidance (GER, late 19 th c, early 20 th c); private foundations (US, first decades of 20 th c).	Public research funding agencies (e.g., NSF, US; Max Planck Gesellschaft, GER; basic research); public and private universities; private foundations (e.g., Gates Foundation; mission oriented research).
Deepening technology base	Ensure widening of applied R&D, lowering risks of diversification and upgrading	Public organization with private funding (SEUM in US, late 18 th c); ministerial R&D departments (UK, 1920s); developmental agency (MITI in JAP, 1949); network of public laboratories (Fraunhofer in GER, 1949; sectoral national laboratories in US, post WWII) – applied research and development.	Variety of public agencies with different degrees of autonomy, size, funding (e.g., DARPA, US; Tekes, FIN; Fraunhofer, GER). Financing and conducting applied research in wide variety of areas. Also tax authorities dealing with R&D tax breaks; public IPR agencies.
Generating demand for new products and services	Generate market power for new technologies, innovations deemed socio-politically important	Ministerial procurement departments with close linkages to inventor networks (mid 19 th c US); private professional organizations for infrastructure standards (mid 19 th c GER); public insurance schemes (health etc, 1880s GER)	Ministerial departments, public regulatory agencies (e.g., FDA, SBIR, US). New products and technologies in wide variety of areas, particularly procurement and incremental improvement of off-the-shelf technologies. International and multilateral trade treaties as access to markets, standardization (WTO, NAFTA).
Diffusion of new skills, technology	Ensure socio-economic benefits from technological advances and innovations	Private business interest associations, cartels, with public support and guidance (mid to late 19 th c, GER)	Public-private partnerships in forms of cluster organizations, technology parks, business incubators, demo centers; public competitions authorities. Particularly technology parks and similar organizations focus on high-tech; competition authorities focus on mergers and similar issues mostly in more traditional fields (market efficiency).

Sources:¹⁰ Carlos and Nicholas 1988; Bowen 2006; Tõnurist and Karo 2016; Kattel and Suurna 2008; Geiger 1986; Hart 1998; Cooke 1975; Nelson Jr. 1979; Rothstein 2015; Gerschenkron 1962; Cameron 1953, 1961, 1967; Sraffa 1930; Kregel 1997; Riesser 1911; Yasuda 1993; Mazzucato and Penna 2015; vom Brocke 1991; also vom Brocke 1996; Gummitt 1980; Boden et al 1998; Basedow 2013; Wilson 2006; Kaiser and Schot 2014; Schmoller 1900; Murmann 2003; Fear 2008; Lanzalaco 2008; Bonvillian and van Atta 2011; Boden et al 1998; Martin 2016.

It is evident from Table 1 that in all innovation policy areas there is and has been a rather wide variety of organizations. We propose that we can draw following two broad-brush lessons from Table 1:

First, at the outset, most innovation policy functions emerge in some form of fluid public-private partnership, often undertaken by relatively small private organization with some form of public support. In effect, innovation bureaucracy organizations seem to emerge as reactions to dynamic technological developments within private sector. Thus, these organizations are called into life to further what can be called Schumpeterian rents from innovations for increasing set of private actors.

Second, however, in time, most innovation policy functions become socialized in one form or other (public sector role becomes more dominant than private initiative) and organizations fulfilling them more ‘bureaucratic’, typically with larger specialized staff, direct public funding, more regulated and managed processes and procedures.

We can here offer only extremely brief (and somewhat anecdotal) evidence for these proposals:

- One of the earliest and successful central banks, the *Reichsbank*, was directly under the guidance of the German Chancellor, yet it was initially privately owned and followed corresponding management practices. (Riesser 1911) One of the key functions of the early *Reichsbank* was to enable long-term industrial financing by private investment banks. (Sraffa 1930) Over the course of 20th century, not only did central banks’ functions change rather drastically

(focusing on fiscal and monetary policy, and since 1980s increasingly only on monetary policy), central banks have also undergone rather significant organizational changes: while up to WWII, it was typical that a central bank was closely related if not situated in finance ministries (that is, part of normal civil service rules), by now central banks are typically public autonomous bodies with their own laws and regulations. (Goodhart 1988; Adolph 2013) In sum, we can argue that central banks have ceased to be part of innovation bureaucracy altogether.

- While evolutionary economists would view Japan's MITI as somewhat archetypical public organization aimed at dealing with technological upgrading of private companies (with strong role played by technical experts) through finance, coordination, regulation, it can be argued that Society for Establishing Useful Manufactures (SEUM) established in 1791 in USA was one of the first attempt to establish a public organization for private sector industrialization efforts. The SEUM was meant as a new industrial town with textile production at its core; it was supposed to be funded by private investors, but under public leadership of Alexander Hamilton and Trench Coxe (see Cooke 1975). The failure of SEUM has been attributed to managers of the company who had almost no industry background: most of them were private financiers looking for short-term returns. (Nelson Jr. 1979) However, particularly East Asian success countries used multiple iterations of MITI-type developmental agencies and councils during their rise. Such agencies with high level political support and key role played by technical experts have evolved in the second half of 20th century into innovation agencies with either narrower policy goals (such as SBIR, DARPA in US) or with rather wide brief

to invest into wider set of technologies and innovations (such as TEKES in Finland). In particular, DARPA's unusual organizational configurations has garnered lot of attention and emulation. (Bonvillian and van Atta 2011; Mazzucato 2013) National innovation funding agencies are similarly to national research funding agencies, the most visible element of modern innovation systems. Another similar feature of such agencies is the impact of new public management ideas (e.g., increasing share of competitive funding, funding projects that 'fix' market failures) that increasingly guide funding decisions and evaluation practices at such organizations.

- Procuring innovative – or often simply products with higher quality and new specifications – has a history in military procurement both in Europe and in US, with the Quartermaster Department in the latter being perhaps one of the forerunners of modern US bureaucracy with its activity during the Civil War and of venture capital industry with its activities during WWII. (Wilson 2006; Weiss 2014) However, military procurement has often had close linkages to civilian inventors (e.g., Eli Whitney); another important strand of procurement is public works. In general procuring innovative products emerges in strongly hierarchical administrative (military) configurations. This is, however, quite different to regulatory and standardization efforts where the evidence is much more mixed. For instance, while railroads were initially developed by private initiatives, later standardization was led by *Verein Deutscher Eisenbahnverwaltungen* in Germany that became dominant force for technical standards in Europe's railway system – but it was initially also a private association (Kaiser and Schot 2014). Similarly, in many emerging industries in the US in the middle of 19th century, private networks were creating and

maintaining standards, with armory industry being the key exception.

(Thomson 2009) Since 1980s and later with the emergence of WTO's regulations, procurement agencies focus increasingly on efficiency and creating level playing fields (Kattel and Lember 2010; Lember et al. 2014; Lember, Kattel and Kalvet 2015).

- Private sector business interest associations and cartels have origins in medieval guilds and later in town management of markets (specifically limiting competition). (Schmoller 1900, 313-315) However, perhaps the most prominent case of publicly supported private cartels is the late 19th and early 20th century German industrialization efforts, later emulated in UK and many other countries. Typically, organizational configurations were very loose in the sense that public sector's role was to coordinate various public policy fields and organizations (from competition and intellectual property to forging linkages with research institutions and applied education institutions). While private cartels have become effectively outlawed in modern economies, in post-WWII era management of competition was a crucial function of developmental agencies in East Asia. Anti-trust agencies of today deal mostly with investigating price collusion and fixing, rarely dipping into innovation arena (with some notable exception, e.g. the EU vs Microsoft court case). Today's equivalents of cartels are variety of R&D consortia, cluster organizations, technology parks, business incubators and accelerators, etc. In all of these organizations, their configurations public leadership and organizational resources are secondary and private funding, initiative and management practices dominate, although with highly varying degrees of success.

- In the developing country context, the influence of foreign and international funders on domestic innovation bureaucracies may be substantial. For instance, during the early post-WWII period, Taiwan created numerous *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 Co-operation and Development (CIECD, 1963–73).¹¹ 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 flexible ties with foreign consultants and counterpart organizations of the US military. An early evaluation of these agencies by Jacoby (1966) argued that while they took-up many policy ideas proposed by the US experts, the organization of these policies/functions tended to remain more ‘locally’ embedded than the US would have preferred. 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 local ruling elite. With increasing political and economic stability after the 1970s, the organizations were gradually integrated into the regular ministerial bureaucracies (see also Breznitz 2007). Similarly, in Eastern Europe, EU has played major role in creating and funding innovation agencies with mixed success mostly because both functions/tasks and organizational designs were exported to the local context without much adaptations, see for a discussion Suurna and Kattel (2010), Karo and Kattel (2014).

III Innovation bureaucracy: analyzing organizational variety

As we attempted to show above, one of the key observations from history of innovation bureaucracies is the oscillation between new fluid (often with substantial input and leadership from private sector) and larger expert organizations; that is, oscillation between Schumpeterian vs Weberian organizations as we described in the introduction. In this section we propose to make this juxtaposition more theoretical using, first, management literature discussing organizational capabilities and ambidexterity and second Weber's own work.

Historically, the idea that different systems of management are suited to different tasks can be traced back at least to Ferdinand Tönnies' research into *Gemeinschaft* and *Gesellschaft* (what he described as organic and mechanistic forms of society; 1887). This is picked up with direct references to Tönnies by management theorists Burns and Stalker (1961) who describe mechanistic and organic management structures: the former to manage stability, the latter to manage change. This is followed up by Duncan (1976) who talks about ambidextrous organizations for the first time, by Mintzberg (1989) who describes five different types of organizations with different capabilities, and by March (1991) who famously differentiates between organizations to exploit existing opportunities and organizations to explore new opportunities. Most recently, such research centers around dynamic capabilities (e.g., Teece 2016; Helfat and Martin 2015) and ambidexterity (e.g., O'Reilly and Tushman 2004 and 2008). Perhaps the simplest way to summarize this line of research is as follows: businesses have 'ordinary' routines and capabilities to exploit existing

strengths and business opportunities but in order to deal with deep market uncertainty, businesses should acquire ‘dynamic’ capabilities. This can take place within the existing organizational structures, but most research seems to show that establishing new, unorthodox organizations (internally or externally) is perhaps better way to deal with ambidexterity. Interestingly, public sector organizations play almost no role in these research lines.

However, as we have attempted to show, there seems to be a similar dichotomy at least in the case of public innovation policy organizations: one type of organization that is typically small, fluid and deals with new emerging issues and sectors; and another type that is larger, based on expertise and skills, more hierarchical and that aims to enhance existing capabilities in private sector through more complex and large-scale activities (provision of public services, regulation, finance, guidance of sectors, or economy as a whole). Calling small fluid agencies Schumpeterian is evocative but hardly justifiable through Schumpeter’s own work. While Schumpeter argued that ‘new men’ can bring forth innovations in all walks of life (from economy to arts), he did not discuss organizational underpinnings (in public sector) in detail. (Schumpeter 1912, 142-157) However, Weber’s taxonomy of domination or authority (traditional, charismatic, rational) and corresponding organizational forms offers a way describe what Schumpeter attempted to show in an analytical way. (2009; see also Samier 2005) That is, Weber offers *theoretical* reasons why different types of organizations can deliver different policy goals and how. For Weber, different forms of authority are created by and rely on different organizations (in terms of their capacities and routines, internal structures and external relations) and what these organizations could deliver. In addition, Weber argued that new organizational forms

(or change from one form to another) emerge through conflicts between old and new leaders and staff (Weber 2009, 154-155), implying potential conflicts over political and policy visions.

In essence we can argue that in the history of innovation bureaucracy we can detect two ideal-typical Weberian organizations and their cyclical evolution:

First, historically most forms of innovation bureaucracy start as one type of Weberian organizations – what we can call Weber I : charismatic, dynamic organizations innovating often in emerging policy areas via proposing new initiatives and regulations, standards, or cooperation forms, and reside often outside of typical government operations and may look like public-private partnerships (but can have high level political support, or enjoy societal prestige), and

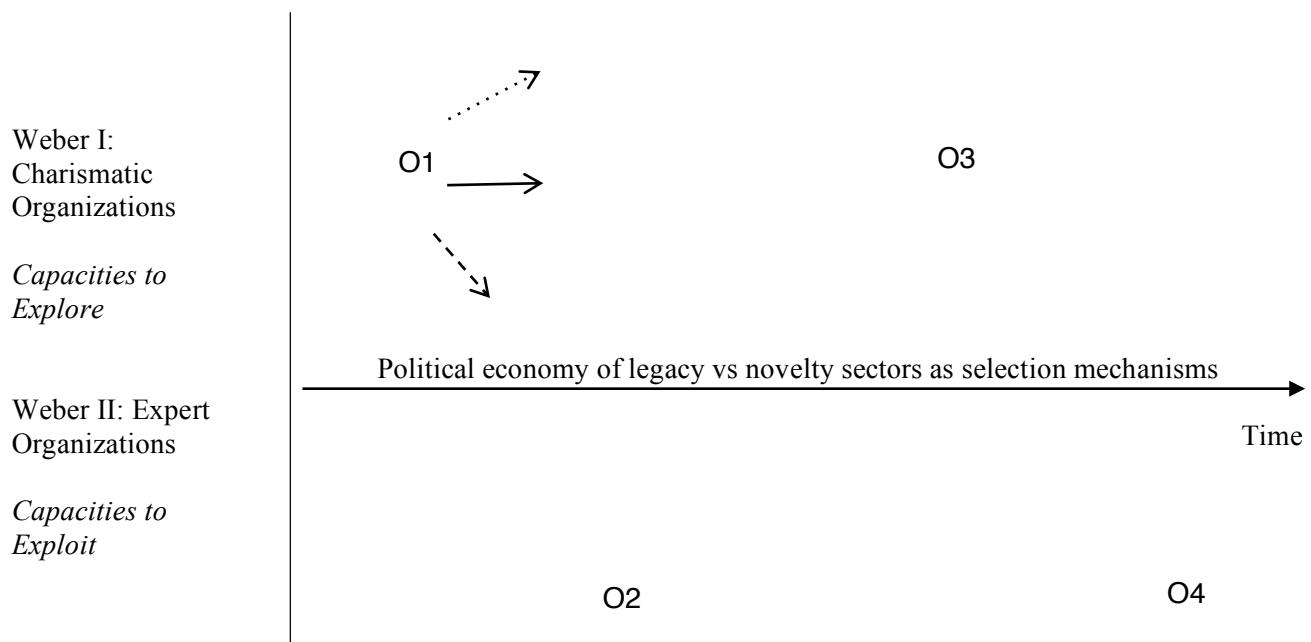
Second, with time they move (or rather ‘grow’) in to another type of Weberian organization – what we can call Weber II: professional, centrally governed organizations that are stable and predictable, manned with high level experts and are strong in enhancing private sector innovation capabilities through public policies during rather stable conditions of technological maturity, or conversely during catching-up or mission dominated periods (i.e. the instrumental performance of these organizations is related to long time horizons, predictability and cost-efficiency that allows for patient regulation and public investment in long-term and complex activities necessary for industrial development and catching-up), and

Third, with new technologies and/or ideologies emerging, innovation bureaucracy can be pushed towards more charismatic form again (recently 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 inhibit private experimentation with new productions, service, or marketing or other methods).

We can see in Weber I and Weber II organizational archetypes of innovation bureaucracy from which formation of hybrid forms is possible and indeed to be expected. As for the selection mechanisms of how Weber I or II types evolve, we can in a simplified way look at political economy relations of legacy vs novelty sectors (Bonvillian and Weiss 2015): both in substance as well as in resistance to changes, it seems that Weber I organizations are well suited for novelty sectors while managing legacy sectors seems to fit with Weber II organizations. As novelty sectors mature, new set of values becomes more important and thus also innovation bureaucracy type evolves. Also vice versa: as legacy sectors find it difficult to innovate (because of strong incumbent public-private networks), Weber I organizations might find it easier to start new initiatives at the edges of legacy sectors (e.g., ARPA-E in energy sector in US). There are two stylized logics here that we can also find in more recent innovation policy thinking. First, catching-up stages and more mature stages of technological life cycles (the key contextual focus of the original developmental state research) require managing visible risks and implementing efficiently established and known policy solutions that can be done through more established and institutionalized (bureaucratic) routines and capacities (stability, patient capital, long-

term orientation). Second, progress at the techno-economic frontier (the focus of most the current West-based innovation policy research) is about dealing with uncertainty and coming up with policy solutions that require more flexible and adaptable forms of organizations and governance. It is, however, safe to assume that in reality there is a more complex organizational variety of hybrids beneath Weberian dichotomy proposed here. (See also Mintzberg 1989) However, our main aim in this article is to show that it is possible to understand innovation bureaucracy in such ideal-typical fashion. Figure 1 summarizes our framework.

Figure 1. Ideal-types and ambidexterity of innovation bureaucracy



Legend: O-Organization; three types of arrows: O continues to exist (arrow with straight line); O changes type (Weber I → Weber II, or Weber II → Weber I), internally or externally (arrow with dashed lined); O ceases to exist (arrow with dotted line).

In order to generally exemplify Figure 1, we can think of following examples: O1 as an entrepreneurial organization can continue to exist in roughly the same form for a number of years (e.g., DARPA in post WWII era), cease to exist (e.g. industry cartels after WWII), or change into more expert type organization (e.g., central banks in early 20 century). O2 an expert organization can continue to exist for a number of years (e.g., NSF, NHS), or change internally into a more entrepreneurial type of organization (e.g., formation of In-q-tel with military-defense complex), or cease to exist (e.g., public industrial banks in Europe).

IV Conclusion

In her recent paper, Mazzucato argues that one of the crucial questions for the innovation research is to understand “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?” (2014, 8) 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)

In this paper we have argued that the current debates on how to organize government actions to support innovation have over-concentrated on single-organization research (different types of ‘agencies’) and single-variable explanations (Weberian elite agencies vs peripheral Schumpeterian agencies). We argue that instead of single-form explanations for how to organize government actions to support innovation, we might

gain greater understanding of these questions by focusing on organizational variety in innovation policy. Indeed, understanding public organizations in their respective feedback context should be the first task towards more entrepreneurial state. We can even argue that lack of entrepreneurial activity (as discussed by Mazzucato) is itself a result of existing organizational landscapes: today's public organizations operate predominantly in politico-administrative context where risk taking, long-term thinking, etc, are not simply frowned upon, but other performance measures (cost-efficiency and cut-backs) have become to dominate over these focuses and priorities and switching to new ones comes at a considerable cost (both politically and administratively). History seems to tell us that under such circumstances new functions/policy goals and new organizational forms gradually emerge to deal with pressing challenges. It depends greatly on whether challenges are brought forward by private actors or by political leadership as this plays an important role in what kind of organizational configurations will be chosen to deal with new challenges, or in rejuvenating existing organizations. 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 evaluations).

Thus, one of the lessons from our research is that entrepreneurial state may require diversity of public sector organizations dealing with innovations and technological change. Second lesson is that there is a crucial difference between initiating new policy goals vs changing existing policy goals and organizations. Third lesson is that in innovation policy arena there are multiple public organizations and these

organizations compete for funding and political support, thus conflicts between policy goals and organizations are bound to be numerous. Accordingly, one of the key issues is how to coordinate the activities and capacities of various public organizations. This would typically call for political leadership to proactively address coordination issues. At the same time, most modern thinking on such coordination seems to lead towards standardization and merger or public sector organizations to gain top-down control and managerial (cost-)efficiencies. Yet, lessons one and two imply that entrepreneurial states require what can be called *ambidextrous innovation systems*, i.e. systems where capacities to explore and exploit are sustained through public-private coordination and institutional complementarities.

As for further research, if governments want to be effective in supporting innovation policy, as scholars we should not only recommend better policy mixes, but also pay attention to the organizational mixes. Further, 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 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 in terms of how to create and maintain ambidextrous innovation systems. It would also be important to understand whether non-Western contexts (with viable alternatives to Western modernization paradigm and with different cultural-religious contexts) play a role in how innovation bureaucracies evolve.

Acknowledgements: Research for this paper was partly supported by the Estonian Research Council's institutional grant IUT19-13.

References

- Adolph, C. (2013). *Bankers, Bureaucrats, and Central Bank Politics. The Myth of Neutrality*, Cambridge: Cambridge University Press.
- Amable, B. (2003). *The diversity of modern capitalism*, Oxford: Oxford University Press.
- Amsden, A. (1989). *Asia's Next Giant: South Korea and Late Industrialization*, Oxford: Oxford University Press.
- Basedow, A. (2013). 'Technology Transfer.' Fraunhofer Center for Central and Eastern Europe, May 9th, Prague/ CZ, pp. 1-36.
- Block, F. (2008). 'Swimming against the current: The rise of a hidden developmental state in the United States', *Politics & Society*, 36(2), pp. 169-206.
- Bonvillian, W.B. and Van Atta, R. (2011). 'ARPA-E and DARPA: Applying the DARPA model to energy innovation', *The Journal of Technology Transfer*, 36(5), pp. 469-513.
- Bonvillian, W.B. and Weiss, C. (2015) *Technological Innovation in Legacy Sectors*, Oxford: Oxford University Press.
- Breznitz, D. (2007). *Innovation and the State: Political Choices and Strategies for Growth in Israel, Taiwan and Ireland*, New Haven: Yale University Press.
- Breznitz, D. and Ornston, D. (2013). 'The Revolutionary Power of Peripheral Agencies: Explaining Radical Policy Innovation in Finland and Israel', *Comparative Political Studies*, 46(10), pp. 1219-1245.
- Boden, R., Gummett, P., Cox, D. and Barker, K. (1998). 'Men in white coats ... men in grey suits', *Accounting, Auditing & Accountability Journal*, 11(3), pp. 267-291.

- Bowen, H.V. (2006). *The Business of Empire: The East India Company and Imperial Britain, 1756-1833*, Cambridge: Cambridge University Press.
- Brocke, B vom. (1996). ‘Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft und ihre Institute zwischen Universität und Akademie. Strukturprobleme und Historiographie’, in B. vom Brocke and H. Laitko (eds.), *Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft und ihre Institute. Studien zu ihrer Geschichte*, Berlin: de Gruyter, pp. 1-34.
- Brocke, B vom. (ed.) (1991). *Wissenschaftsgeschichte und Wissenschaftspolitik im Industriezeitalter. Das “System Althoff” in historischer Perspektive*, Hildesheim: Lax Verlag.
- Burns, T. and Stalker, G.M. (1961). *The Management of Innovations*, London: Tavistock.
- Cameron, R. (1953). ‘The Crédit Mobilier and the Economic Development of Europe’, *Journal of Political Economy*, 61(6), pp. 461-488.
- Cameron, R. (1967). *Banking in the Early Stages of Industrialization*, Oxford: Oxford University Press.
- Cameron, R. (1961). *France and the Economic Development of Europe, 1800-1914: Conquests of Peace and Seeds of War*, London: Routledge.
- Carlos, A. and S. Nicholas (1988). “‘Giants of Capitalism’: The chartered trading companies as modern multinationals”, *The Business History Review*, 62(3), pp. 398-419.
- Chandler, A. (1977). *The Visible Hand. The Managerial Revolution in American Business*, Cambridge, MA and London: The Belknap Press of Harvard University Press.

- Cheng, T.J., Haggard, S. and Kang, D. (1998). ‘Institutions and Growth in Korea and Taiwan: The Bureaucracy’, *Journal of Development Studies*, 34, pp. 87-111.
- Cimoli, M., Dosi, G. and Stiglitz, J. (2015). ‘The Rationale for Industrial and Innovation Policy’, *Revista do Serviço Público Brasília*, 66, pp. 55-68.
- Cooke, J.E. (1975). ‘Tench Coxe, Alexander Hamilton, and the Encouragement of American Manufactures’, *The William and Mary Quarterly*, 32(3), pp. 369-392.
- Drechsler, W. (2005). ‘The rise and demise of the new public management’, *post-autistic economics review* 33, pp. 17-28.
- Drechsler, W. (2016). ‘The German Historical School and Kathedersozialismus’, in: Ghosh, J., Reinert, E.S., Kattel, R. (eds.), *The Elgar Handbook of Alternative Theories of Economic Development*, London: Edward Elgar Publishing, forthcoming.
- Duncan, R.B. (1976). ‘The ambidextrous organization: designing dual structures for innovations’, in R.H. Kilmann, L.R. Pondy and D.P. Slevin (eds.), *The Management of Organization Design. Strategies and Implementation*, Vol.1, New York, Oxford, Amsterdam: North-Holland, 167-188.
- The Economist (2016). ‘Mandarin lessons’, March 12, 2016,
<http://www.economist.com/node/21694553/>.
- Edquist, C. and Hommen, L. (eds.) (2009). *Small country innovation systems: globalization, change and policy in Asia and Europe*, Cheltenham: Edward Elgar Publishing.
- European Commission (2013). *Lessons from a Decade of Innovation Policy. What can be learnt from the INNO Policy TrendChart and The Innovation Union Scoreboard*, Brussels: European Commission.

- Evans, P. (1995). *Embedded Autonomy: States and Industrial Transformation*, Princeton: Princeton University Press.
- Evans, P. (1998). ‘Transferable lessons? Re-examining the institutional prerequisites of East Asian economic policies’, *The Journal of Development Studies*, 34(6), pp. 66-86.
- Evans, P. and Rauch, J.E. (1999). ‘Bureaucracy and growth: a cross-national analysis of the effects of ‘Weberian’ state structures on economic growth’, *American Sociological Review*, pp. 748-765.
- Fear, J. (2008). ‘Cartels’, in G. Jones and J. Zeitlin (eds.), *The Oxford Handbook of Business History*, Oxford: Oxford University Press, pp. 268-292.
- Flanagan, K and Uyarra, E. (2016). ‘Four dangers in innovation policy studies – and how to avoid them’, *Industry and Innovation*,
<http://dx.doi.org/10.1080/13662716.2016.1146126>
- Geiger, R.L. (1986). *To Advance Knowledge. The Growth of American Research University 1900-1940*, Oxford: Oxford University Press.
- Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective*. Belknam Press.
- Goodhart, C. (1988). *The Evolution of Central Banks*, 2nd ed., Cambridge, MA: The MIT press.
- Gummitt, P. (1980). *Scientists in Whitehall*, Manchester: Manchester University Press.
- Haggard, S. (1990). *Pathways from the Periphery: The Politics of Growth in the Newly Industrializing Countries*, Ithaca: Cornell University Press.
- Hart, D.M. (1998). *Forged Consensus. Science, Technology, and Economic Policy in the United States, 1921-1953*, Princeton: Princeton University Press.

- Helpat, C.E. and Martin, J.A. (2015). ‘Dynamic Managerial Capabilities: Review and Assessment of Managerial Impact on Strategic’, *Journal of Management*, 41, pp. 1281-1312.
- Hollingsworth, J.R. and Boyer, R. (eds.) (1997). *Contemporary capitalism: The embeddedness of institutions*, Cambridge: Cambridge University Press.
- Hoskin, K.W. and Macve, R.H. (1988). ‘The genesis of accountability: The west point connections’, *Accounting, Organizations and Society*, 13(1), pp. 37–73.
- Hoskin, K.W. and Macve, R.H. (1994). ‘Reappraising the Genesis of Managerialism’, *Accounting, Auditing & Accountability Journal*, 7(2), pp. 4-29.
- Jacoby, N. H. (1966). *US aid to Taiwan; a study of foreign aid, self-help, and development*, New York: Frederick A. Praeger.
- Johnson, C. (1982). *MITI and the Japanese Miracle: The Growth of Industrial Policy*, Stanford: Stanford University Press.
- Kaiser, W and Schot, J. (2014), *Writing the Rules for Europe. Experts, Cartels, and International Organizations*, Basingstoke: Macmillan.
- Karo, E., and Kattel, R. (2014). ‘Public Management, Policy Capacity, Innovation and Development’, *Brazilian Journal of Political Economy*, 34(1), pp. 80-102.
- Kattel, R.; Cepilovs, A.; Drechsler, W.; Kalvet, T.; Lember, V.; Tõnurist, P. (2014). ‘Can we measure public sector innovation? A literature review’, *LIPSE Working papers*, 2, pp. 1-45.
- Kattel, R. and Suurna, M. (2008). ‘The rise and fall of the Estonian genome project’, *Studies in Ethics, Law, and Technology*, 2(2), doi: [10.2202/1941-6008.1050](https://doi.org/10.2202/1941-6008.1050).
- Kattel, R., and Lember, V. (2010). ‘Public Procurement as an Industrial Policy Tool: An Option for Developing Countries?’ , *Journal of Public Procurement*, 10(3), pp. 368–404.

- Kregel, J. (1997). *The Past and Future of Banks*, Roma: Ente Einaudi.
- Lam, A. (2006). ‘Organizational innovations’, in J. Fagerber, D. Mowery and R. Nelson, (eds.), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 115-147.
- Lanzalaco, L. (2008). ‘Business interests associations’, in G. Jones and J. Zeitlin (eds.), *The Oxford Handbook of Business History*, Oxford: Oxford University Press, pp. 293-315.
- Lember, V., Kattel, R. and Kalvet, T. (eds.) (2014). *Public Procurement, Innovation and Policy: International Perspectives*, Heidelberg: Springer.
- Lember, V., Kattel, R. and Kalvet, T. (2015). ‘Quo vadis public procurement of innovation?’, *Innovation: The European Journal of Social Science Research*, doi:10.1080/13511610.2015.1043245.
- Levi-Faur, D. (1998). ‘The Developmental State: Israel, South Korea, and Taiwan Compared’, *Studies in Comparative International Development*, 33(1), pp. 65-93.
- Lundgreen, P. (1990). ‘Engineering education in Europe and the U.S.A., 1750–1930: The rise to dominance of school culture and the engineering professions’, *Annals of Science*, 47(1), pp. 33-75.
- Lundvall, B.-A. (2013). ‘Innovation Studies: A personal interpretation of “the state of the art”’, in J. Fagerberg, B. R. Martin and E. S. Andersen (eds.), *Innovation Studies. Evolution and Future Challenges*, Cheltenham: Elgar, pp. 21-70.
- Manchester Institute of Innovation Research (2012). *Compendium of Evidence on the Effectiveness of Innovation Policy Intervention*, London: Nesta.

- March, J.G. (1991). ‘Exploration and Exploitation in Organizational Learning’, *Organization Science*, 2(1), Special Issue: *Organizational Learning: Papers in Honor of (and by) James G. March*, pp. 71-87.
- Martin, B. (2016). ‘What is happening to our universities?’, *SPRU Working Papers*, 2016-03.
- Mazzucato, M. (2014), ‘A mission-oriented approach to building the entrepreneurial state’, A ‘think piece’ for the Innovative UK:
<http://mariamazzucato.com/wp-content/uploads/2014/11/MAZZUCATO-INNOVATE-UK.pdf>
- Mazzucato, M. (2013), *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*, Anthem Press.
- Mazzucato, M. and C. Penna (2015). “Beyond Market Failures: The Market Creating and Shaping Roles of State Investment Banks”, *Levy Institute of Bard College Working Paper*, 831.
- Mintzberg, H. (1989). *Mintzberg on Management: Inside our strange world of organizations*, Simon and Schuster.
- Murmann, P. 2003. *Knowledge and Competitive Advantage*, Cambridge: Cambridge University Press.
- Nistotskaya, M. and Cingolani, I.V. (2014). ‘Bureaucratic structure, regulatory quality and entrepreneurship in a comparative perspective’, *QoG Working Paper Series*, 08.
- Nelson, Jr., J. (1979). ‘Alexander Hamilton and American Manufacturing: A Reexamination’, *The Journal of American History*, 65(4), pp. 971-995.
- Nelson, R. R., and Winter, S.G. (1982), *An evolutionary theory of economic change*, Harvard University Press.

- O'Reilly, C.A. III and Tushman, M.L. (2004). 'The ambidextrous organizations', *The Harvard Business Review*, April 2004, pp. 74-81.
- O'Reilly, C.A. III and Tushman, M.L. (2008). 'Ambidexterity as a dynamic capability: Resolving the innovator's dilemma', *Research in Organizational Behavior*, 28, pp. 185-206.
- O'Riain, S. (2004). *The Politics of High Tech Growth: Developmental Network States in the global Economy*, Cambridge University Press, Cambridge.
- Padgett, J.F. and W.W. Powell (eds.) (2012). *The Emergence of Organizations and Markets*, Princeton & Oxford: Princeton University Press.
- Puttick, R., Baeck P. and Colligan P. (2014) *The teams and funds making innovation happen in governments around the world* (Nesta):
http://theiteams.org/system/files_force/i-teams_June%202014.pdf.
- Rauch, J. E. and Evans, P. B. (2000). 'Bureaucratic structure and bureaucratic performance in less developed countries', *Journal of public economics*, 75(1), pp. 49-71.
- Riesser, J. (1911). *The German Great Banks and Their Concentration in connection with the Economic Development of Germany*, Washington: Government printing office.
- Rothstein, B. (2015). 'The Chinese Paradox of High Growth and Low Quality of Government: The Cadre Organization Meets Max Weber', *Governance*, 28(4), pp. 533-548.
- Samier, E. (2005). 'Toward a Weberian Public Administration: The infinite web of history, values, and authority in administrative mentalities', *Halduskultuur*, 6, pp. 60-94.

Schmoller, G. von (1900). *Grundriß der Allgemeinen Volkswirtschaftslehre*, Teil 1, Leipzig: Duncker&Humblot.

Schumpeter, J. A. (1912). *Theorie der wirtschaftlichen Entwicklung*, Berlin: Duncker&Humblot.

Sraffa, P. (1930). Lecture notes on Continental Banking. Trinity College.
Unpublished.

Suurna, M. and Kattel, R. (2010). ‘Europeanization of innovation policy in Central and Eastern Europe’, *Science and Public Policy* 37(9), pp. 646-664.

Teece, D.J. (2016). ‘Dynamic capabilities and entrepreneurial management in large organizations: toward a theory of the (entrepreneurial) firm’, *European Economic Review*, <http://dx.doi.org/10.1016/j.eurocorev.2015.11.006i>

Thomson, R. (2009). *Structures of Change in the Mechanical Age. Technological Innovation in the United States, 1790–1865*, Baltimore: The Johns Hopkins University Press.

Tõnurist, P., Kattel, R., and Lember, V. (2015). ‘Discovering Innovation Labs in the Public Sector’, *Working Papers in Technology Governance and Economic Dynamics*, 61:

<http://technologygovernance.eu/files/main//2015062509192727.pdf>.

Tõnurist, P. and E. Karo (2016). ‘State owned enterprises as instruments of innovation policy’, *Annals of Public and Cooperative Economics*, doi: 10.1111/apce.12126 .

Tönnies, F. (1887). *Gesellschaft und Gemeinshaft*, Leipzig: Fues's Verlag.

Wade, R. (1990). *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, Princeton: Princeton University Press.

Weber, M. (1922/2009). *Economy and Society*, University of California Press (ed. by Gross, G. and Wittich, C.).

Weiss, L. (2014). *America Inc.? : Innovation and Enterprise in the National Security State*, Cornell University Press.

Wilson, M. (2006). The Business of Civil War. Military Mobilization and the State, 1861–1865, Baltimore: The Johns Hopkins University Press.

Wu, Y. (2004). ‘Rethinking the Taiwanese developmental state’, *The China Quarterly*, 177, pp. 91-114.

Yasuda, A. (1993). *The Performance and Roles of Japanese Development Banks*, Graduate Thesis, Department of Economics, Stanford University.

¹ On the importance and relevance of von Schmoller and the German historical school, see most recently Drechsler 2016.

² Here and below we use innovation policy in the widest possible sense: in our view it includes all public policies that consciously aim to promote R&D, innovations and technological change. On why such usage is justified, see Lundvall 2013.

³ In the recent meta-evaluations of innovation policies, implementation issues have not received any attention. Such evaluations discuss in detail the effectiveness of various policies and policy mixes, but not whether design and implementation of these policies and policy mixes plays any role in the effectiveness. See European Commission 2013 and Manchester Institute of Innovation Research 2012. OECD country studies of innovation policy typically describe implementing agencies but rarely go into analytical details (e.g., whether a success of a measure has anything to do with the agency implementing it or not).

⁴ In the context of public sector innovations we see a somewhat similar trend where organizations tasked with innovating within public organizations or services (innovation or design labs), tend to be established as at arms length institutions, with low budgets and political profiles but with highly charismatic leaders, broad independence in agenda setting and with high level of experimentation (e.g.,

Nesta in the UK, Mindlab in Denmark; see Puttick et al. 2014, Tõnurist et al. 2015, also Kattel et al 2014).

⁵ This is best captured by Chalmers Johnson and his concept of *developmental state*: a country with predominant *policy orientation towards development* supported by small and inexpensive *elite bureaucracy* centred around a *pilot organization*, such as MITI in Japan, with *sufficient autonomy* (limited intervention by the legislative and judiciary) to identify and choose best industries to be developed and to choose 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).

⁶ Their original questionnaire (available here: <http://econweb.ucsd.edu/~jrauch/codebook.html>) does not in fact contain any questions about institutional or organizational structures, or about their politico-administrative position in policy systems, or about capacities. This is all the more striking as the period they cover – 1970-1990 – saw in many countries arguably the deepest administrative reforms of past 100 years, namely the rise of new public management type of managerialism and copying of private sector practices. On the latter, see Drechsler 2005.

⁷ For a wider discussion of why and how institutional inventions take place, see Padgett and Powell 2012.

⁸ Engineers play also a crucial role in some countries in professionalizing civil service in early 19th century and helped to by-pass existing patrimonial structures; see comparative study by Lundgreen 1990.

⁹ For our purposes it is not important whether the professional managers were born in private or public sectors (for a discussion, see Chandler 1977, Hoskin and Macve 1988 and 1994; also Wilson 2006); it is, however, important that in both sectors it happens around the same time in mid 19th century.

¹⁰ Organizational aspects are rarely discussed in detail in historical works, thus we have gleamed together organizational facts from various sources through extensive ‘snowballing’ efforts to cover historical literature.

¹¹ See Levi-Faur (1998) on the importance of US aid and guidance of technological development in some of the key modern innovation success stories, i.e. Taiwan, South Korea and Israel.