

# The Bit and the Rainforest:

## Towards an Evolutionary Theory of Policy Capacity

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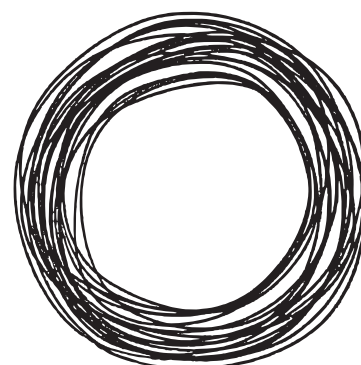
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# The Bit and the Rainforest:

## Towards an Evolutionary Theory of Policy Capacity

Erkki Karo & Rainer Kattel<sup>1</sup>

### Abstract

Richard Nelson showed in his seminal *The Moon and the Ghetto* (1977) that there are some socio-economic challenges that cannot be solved solely through advances in technology – we have the know-how that gets us to the moon but not the know-how to ‘solve’ the ghetto. Some challenges require different kinds of knowledge and expertise from the public sector. Following Nelson, we can argue that today our societies are increasingly apt in creating and using data (bits), yet data alone will not save the rainforests from climate change. In other words, directing or steering innovations and know-how to solve ‘wicked’ or grand challenges requires a different approach to policy making. In this paper, we propose an evolutionary analytical approach to policy capacity with a specific focus on policy domains where uncertainty and need for policy innovations is a central concern for effective policies. From an evolutionary perspective, the core elements of policy capacity are: a) organizational routines and their varieties, b) search and selection and the endogenous and exogenous sources of novelty creation, c) selection and feedback environments. We operationalize these elements and illustrate the value of the evolutionary analytical perspective through a discussion of the evolution of science, technology and innovation (STI) policy capacities of three Asian Tigers: South Korea, Taiwan and Singapore.

**Keywords:** innovation; societal challenges; evolutionary theory of policy capacity; organizational routines; organizational variety.

JEL: O25, O38, O43.

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# 1 Introduction

Innovation is one of the key modern catchwords regarding the role of the state in economy and society, but it can also offer a promising lens on public-policy processes and for bridging different silos of social-science research. It is widely recognized that the state and public policies can influence the speed and direction of innovation *in markets* (through the implementation of conventional and/or mission-oriented science, technology and innovation – STI – policies), *within government* policies, services, institutions and organizations (through policy and public-sector innovation), and *in society* in general (by supporting social innovation) (Fagerberg et al., 2013; Mazzucato, 2013 and 2017; de Vries et al., 2015; Voorberg et al., 2015).

Evolutionary economists – who have done the most extensive work in developing the concept of innovation (see Fagerberg et al., 2013; Godin, 2012; Witt, 2008) – treat innovation as an inherently *evolutionary* phenomenon characterized by uncertainties, dynamism, frequent failures and constant learning. According to Witt (2002), an evolutionary theory in whatever field is a) *dynamic*, b) *historical* (deals with historical processes that are irrevocable and path-dependent) and, crucially (the most challenging aspect), c) has to *explain self-transformation* (including hypotheses relating to the source and driving force of the self-transformation of the system, be it a firm, industry, or government). Therefore, innovation as a phenomenon is quite difficult to theorize, model and measure because it is influenced by both exogenous and endogenous variables and because ‘endogenous change originates, in the last resort, from the capacity of the system under investigation to produce novelty’ (Witt, 2002, p. 11).

Regardless of these difficulties, and as innovation is seen as the root of socio-economic dynamism (for economic development and socio-economic problem-solving), the main goals of evolutionary economists are to understand a) technological and social transformations and development with a specific focus on the *generation of new ideas and solutions, or novelty* (technological, procedural, or institutional, organizational); b) their successful implementation and *diffusion* in a specific context (organizations, markets, states, society); and c) their eventual *decline* and/or substitution with something more novel. Research on public-sector and public-policy innovation has emerged from rather similar goals: to understand and explain the emergence of radical changes and novelty in the public sector while most public sector changes tend to be incremental and path-dependent. Thus, innovation in the public sector is not just any change, but substantive change through risky and uncertain novelty creation and its application and diffusion (Kattel, 2015; Karo & Kattel, 2016a). While most disciplines interested in innovation seem to agree that the innovative public organizations or state in general need to be equipped with specific *capacities* for bringing about innovation in government policies, services, institutions and organizations, or for supporting innovation in markets and society in general, they seem to find it difficult to properly theorize and operationalize the concept of ‘capacity’ (see Karo & Kattel, 2014).

Recent advances in public-policy studies have provided useful analytical lenses to further our thinking. By focusing on the concept of policy capacity, defined as the ‘set of skills and resources – or competencies and capabilities – necessary to perform policy functions’ (Wu et al., 2015, p. 166), Wu et al. are able to bring into a single framework core policy-related *skills and competences* (political, analytical, operational). These are closely linked to different policy



functions, from political decisions to policy design and implementation influenced by individual-, organizational- and institutional-level factors (determinants of skills and competences). This approach is quite similar to the general management literature, especially on dynamic managerial capabilities (see Helfat & Peteraf, 2015; Teece, 2016). Yet, most debates on the role and capacities of the state regarding innovations both in government and in markets and society have focused on only a few of these functions and related skill-sets, usually on a single level of analysis. Further, these debates seem to converge on a common, simplified question: should we stick to modernizing classic bureaucratic meritocracies or move towards experimental, start-up-like governments through changes on the individual, organizational and/or systemic levels (see Kattel, 2015; Karo & Kattel, 2016b)? Public policy and management research on policy capacities seems to have at least two limitations that evolutionary innovation research could help to overcome.

*First*, the operationalization of policy capacities is mostly done on the level of *outcomes*, i.e., the ‘ability’, ‘efficiency’ or ‘effectiveness’ of certain political, analytical or operational skills, competencies and resources to contribute to public-policy goal attainment (e.g. Howlett, 2015; Painter & Pierre, 2005; Polidano, 2000). In other words, the concept of capacity itself remains static in such analytical frameworks – capacity is either there or not. This static nature of capacity renders the concept implicitly teleological and normative: if certain capacities are not existing, the organizations should find ways to obtain them. Yet, the crucial characteristics of innovation is the ‘uncertainty’ of the innovation and novelty creation in terms of both *processes* (how innovation and novelty creation take place in different organizations and systems) and *outcomes* (which new technologies and processes will emerge out of research, development and experimentation and diffuse in and across organizations and systems). Consequently, also the role of the public organizations and policies in innovation is highly uncertain and contextual. For example, some innovation-policy scholars have tried to operationalize the role of the state in supporting innovations in markets and society as correcting market, system and/or transformative system failures (see Weber & Rohracher, 2012). Others have criticized this failures approach, as it makes the role of the state too static and oversimplifies the uncertainties of innovation (Mazzucato, 2016). The state can act as a ‘technology maker’ or innovator (Karo & Kattel, 2016a), taking on the uncertainties of innovation through direct policy design and implementation activities. In other words, innovations in government and in markets/society become highly interlinked. In this context, it seems somewhat speculative to assume what constitutes policy capacities. Such uncertainty of policy pathways characterizes also other complex societal challenges (see Pollitt, 2016).

*Second*, most public management and policy research seems to focus predominantly on *exogenous* variables to explain the emergence and evolution of policy capacities, such as financial and authority-based resources allocated to an organization or a policy domain, or the general context of education and training of potential civil servants (by both the educational and the civil-service systems; Painter & Pierre, 2005; Polidano, 2000; Wu et al., 2015). As mentioned, evolutionary approaches to innovation and organizational and industrial capabilities try to explicitly understand both the exogenous and the endogenous factors influencing individual,

organizational and system-level innovation processes and novelty creation (Nelson & Winter, 1982; Witt, 2008).<sup>2</sup>

The unevenness of how societies create knowledge and learn to solve socio-economic challenges was pointed out by Richard Nelson in his seminal *The Moon and The Ghetto* (1977). We might paraphrase his title and the question – why can we send man to the moon but cannot deal with the ghetto in terms of education, health, and so forth – as *The Bit and the Rainforest*. While our current form of capitalism is increasingly good at using data – there are thousands and thousands of new apps added to various appstores and thousands of clouds filled with unprecedented amounts of data – no matter how many more apps we produce or how much more data we gather it is unlikely to solve climate change and save rainforests. The question is particularly pertinent if we were to ask it in terms of directionality of innovations: what enables societies to steer innovations to solve problems that are seemingly ‘wicked’ and almost unsolvable? While Nelson focused on various sets of know-how, their formation and use in policy processes, we would like to propose a complimentary perspective to this: namely, that of policy capacities as a conceptual approach to understand why certain kinds of problems are solved through innovations and others are not. Nelson argues that the nature of the know-how used in policy processes determines the way we understand performance in specific policy fields. Getting man to the moon is an achievement that is based on replicable processes of knowledge; raising well-behaved citizens is quite a different story (Nelson, 2011). Hence, policy fields exhibit different degrees of variability of good/poor performance (see also Hirschman, 1967). While most of us would intuitively agree with this, actual policy-making rarely does take the variability of performance into account. Modern governments tend to rely on unified and holistic budgetary and performance systems in which all activities of government are seen through the same lenses. The roots of such a framework are to be found in the core of mainstream economics and its view of the human being (see already Veblen, 1898). For public management, however, the reform waves of the 1980s and 1990s – also known as New Public Management (Drechsler, 2005) – created a particularly strongly unified and specific vision of public-sector performance. As argued by Bouckaert and Peters (2002), this meant focusing on the ‘visible performance’ of lower-level activities and not on higher-level (e.g. cross-organizational) policy fields. As they put it, ‘a “helicopter view” is competing with a detailed and sometimes myopic “frog view” for a performance management approach’ (p. 360). We argue that at the heart of both the bit and the rainforest problem and the helicopter vs. frog view rests the same challenge of poorly understood policy capacities.

In this paper we propose an evolutionary analytical approach to policy capacity with a specific focus on policy domains, where uncertainty and need for policy innovations, or novelty creation, is a central concern. We use the generic framework of policy capacity developed by Wu et al. (2015). In the next section, we will briefly review the key theoretical and conceptual contributions of evolutionary economics to general innovation and also public policy and management research. We propose a simplified evolutionary analytical approach to policy capacity, where

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<sup>2</sup> Still, regarding the role of the state and public policies in these processes, even evolutionary and policy-oriented scholars have mostly relied on approaches to policy capacities developed by neo-institutional economists and heterodox political economists (relying on concepts such as ‘coordinative’ and ‘transformative’ capacity—see Grindle, 1996; Polidano, 2000; Weiss, 1998; Weiss & Hobson, 1995), or borrowed from public-management research (using and testing the assumptions of Weberian meritocracies or ‘good governance’—see Evans & Rauch, 1999; Rauch & Evans, 2000; Nistotskaya & Cingolani, 2014).

policy capacity is operationalized through the concepts of *routines*, *search* and *selection*, as well as *punctuated selection and feedback environments*. Thereafter, we illustrate the analytical value of this approach through a stylized discussion of the evolution of science, technology and innovation (STI) policy capacities in three Asian Tigers: Taiwan, South Korea and Singapore.

## 2 Towards an Evolutionary Theory of Policy Capacity

### 2.1 The Basics of the Evolutionary Theory of Innovation

One of the most important contributions to the evolutionary theory of innovation is the neo-Schumpeterian theory and analysis of economic change, and the role of public policies in it, by Nelson and Winter (1982). They use (metaphorically) the generic Darwinian heuristic (variation, selection and retention) to conceptualize the creation of novelty and transformation processes in firms and industries while trying to consider both endogenous and exogenous causes (also Witt, 2002; 2008).

The crucial theoretical contribution of the neo-Schumpeterian perspective to the analysis of innovation is to focus on the *organizational level* by looking at firms (and organizations in general) as crucial actors of innovation. The basic assumption is that complexities of technological and social innovations – encompassing not just the creation of novelty, but its implementation and diffusion – require higher levels of organization and coordination than can be achieved by individuals and ‘primary groups’ (see also Litwak & Figueira, 1968). At the same time, the analysis of these processes on the level of institutions – and especially following the predominant neo-institutional definition of institutions as ‘constraints’ rather than ‘enablers’ of innovation and development, or as ‘social technologies’ (Nelson & Nelson, 2002) – may be again too abstract. There would be a threat of overlooking the potential evolutionary dynamics and novelty creation in different organizations, industries (as systems of organizations) and global, national, regional, sectoral, technological ‘systems of innovation’, where organizations with different capabilities and capacities compete, interact, network and co-evolve to produce evolutionary changes (see Nelson, 1994).<sup>3</sup>

Analytically, the crucial unit of analysis for understanding organizational capabilities for novelty creation and innovation is *organizational routine*:

We use this term to include characteristics of firms that range from well-specified technical routines for producing things, through procedures for hiring and firing, ordering new inventory, or stepping up production of items in high demand, to

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<sup>3</sup> In the context of economic development and change, new institutional economics has tried to encompass these evolutionary processes by adding to the concept of ‘allocative efficiency’ also that of ‘adaptive efficiency’ (see North, 2005), but it has not been very fruitful in moving beyond the outcomes-based perspective of institutions. Most analyses seem to end up focusing on ‘enablers’ of adaptive efficiency, e.g. *credible commitment* by the state to incentivize actors and organizations to engage in learning and innovation; policy-making *accountability* that provides actors and organization incentives to pursue trial-and-error searches under uncertainty (see Schlosstein, 2009; Ahrens, 2002). These are again assumed to be universally delivered by certain policy activities and institutions (or policy capacities). Thus, the perspective of evolutionary systems of innovation has become the key analytical lens for studying techno-economic developments and innovation supporting *policies* across the globe. Recent attempts seek to extend this also to study social innovation more broadly (see in Fagerberg et al., 2013).

policies regarding investment, research and development (R&D), or advertising, and business strategies about product diversification and overseas investment. In our evolutionary theory, these routines play the role that genes play in biological evolutionary theory. They are a persistent feature of the organism and determine its possible behavior (though actual behavior is determined also by the environment); they are heritable in the sense that tomorrow's organisms generated from today's (for example, by building a new plant) have many of the same characteristics, and they are selectable in the sense that organisms with certain routines may do better than others, and, if so, their relative importance in the population (industry) is augmented over time (Nelson & Winter, 1982, p. 14).

Evolutionary scholars treat routines as the most micro-level collective or organizational concept that is similar to individual habits (see Becker, 2008). According to Cohen et al. (1996, p. 683), 'A routine is an executable capability for repeated performance in some context that has been learned by an organization in response to selective pressures.' The key terms of the definition are 'capability', 'context', 'learned', and 'selective pressures' that the researchers need to operationalize, given the specific problems or observations studied. In other words, 'routines are not behaviour; 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' (Hodgson, 2008, p. 23). Importantly, routines are not conceptually teleological or normative (there is not one single ideal routine to be obtained or learned). This also means that the idea of routines is not based on some ideal-typical features of human beings (e.g. rationality or inborn morality). However, we can argue that real existing routines are themselves expressions of an existing political economy – that is, routines are deontic in nature (Searle, 2006).

Linking the individual-behavioral- and organizational-level perspectives, evolutionary scholars recognize that routines emerge in specific organizational contexts through individual and collective learning (Nelson & Nelson, 2002), as organizations provide a structured social and physical environment (explicit and implicit rules and norms of behavior) for each individual:

This environment is made up of the other individuals, the relations between them and the technological and physical artefacts that they may use in their interactions. This social and physical environment enables, stimulates and channels individual activities, which in turn can help trigger the behaviour of others, produce or modify some artefacts, and help to change or replicate parts of this social and physical environment. Partly because of procedural memory, organization can have important additional properties and capacities that are not possessed by individuals taken severally (Hodgson, 2008, p. 22).

As a result, some activities become routinized in organizations, so that organizations (and individuals in organizations) can focus their (creative) resources on other emerging or more uncertain activities. The concept of routine is also central to understanding innovation, as organizations tend to rely on, or lock in to, existing routines due to *path dependencies* and *positive feedback* dynamics (see Nelson & Winter, 1982; Arthur, 1994; Pierson, 2004). This 'makes firms' past experience increasingly important in predicting future actions – flexibility of

routinized behaviour is of limited scope and changing environment increases the unpredictability and risks of survival in case the firms opt to modify routines' (Nelson & Winter, 1982, p. 400).

In principle, *innovative organizations* are the ones that engage in the *search* (for novelty) that denotes 'all those organizational activities which are associated with the evaluation of current routines and which may lead to their modification, to more drastic change, or to their replacement' (Nelson & Winter, 1982, p. 400). This search for novelty is characterized by irreversibility, uncertainty and contingency (it is historically contextual; Nelson & Winter, 1982, pp. 171–172; also Wilson, 1966). Further, search is highly interlinked to *selection* (a process analogous to 'natural selection' in evolution, or competition of different routines and organizations with uncertain outcomes). Sometimes the search for novelty itself is routinized (there exist routines for 'innovation' in the sense of research and development, learning and experimentation) while at other times it may grow out of non-routinized situations, e.g. *conflict* and *competition* between members of an organization or between organizations within a system, or *autonomy* of the organization or system to invest in the search for novelty as a result of managerial or financial 'slack'.<sup>4</sup> Mintzberg's (1989) work on managerial tasks (and implicitly organizational routines) and how these become coupled into different *organizational configurations* with their specific routines, capabilities and pressures for change is, to our knowledge, one of the more systematic treatments of these issue (see also Karo & Kattel, 2016b).

Linking the organizational focus and system/institutional-level analysis, evolutionary theory recognizes that organizational routines and search and selection processes are embedded in the *selection environment* – that is, 'the ensemble of considerations which affect the well-being of the organization and hence the extent to which it expands or contracts. This is partly determined by conditions outside the firms in the industry or sector being considered, but also by the characteristics and behaviour of the other firms in the sector' (Nelson & Winter, 1982, p. 401). We can conceptualize this also as the *feedback environment*, or context (Pierson, 2004; Karo & Kattel, 2014) comprising relevant (for the organization and system in focus) endogenous and exogenous factors influencing organizational routines, search and novelty creation.

In sum, 'through the joint action of search and selection, the firms evolve over time, with the condition of the industry in each period bearing the seeds of its condition in the following period' (Nelson & Winter, 1982, p. 17). Evolutionary economics further assumes that technological progress is one of the key drivers of organizational and institutional learning and evolution, at least in the private sector and market context (Nelson & Nelson, 2002). Modern innovation studies in the private sector seek to analyze both endogenous and exogenous causes of novelty, innovation and its diffusion, persistence and decline on different levels from single organizations to industries and different systems of innovation. Thus, organizational capabilities for innovation are best understood by focusing on a) organizational routines (and resulting firm- and industry-level capabilities); b) search and selection processes and the endogenous and exogenous sources of novelty creation; and c) selection and feedback environments.

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<sup>4</sup> See also Thompson (1965) and Wilson (1966), who discuss these issues in the context of bureaucratic organizations; and also the dynamic-managerial-capabilities research (Helfat & Peteraf, 2015; Teece, 2016), which focuses on the routinized vs. dynamic processes in organizations, although the concept of capabilities remains somewhat normative also here.

## 2.2 Towards an Evolutionary Perspective of Policy Capacity

The neo-Schumpeterian perspective also recognizes that on the system level, there are co-evolutionary linkages between firms and industries and public policies. Nelson and Winter write, 'public laws, policies, and organizations are an important part of the environment that shapes the evolution of private sector activities' (e.g. search prospects and costs, whether it is feasible to imitate vs. innovate), and 'although for some purposes it is useful to think of public laws, policies, and organizations as being part of the landscape, these, like private sector activities, undergo continuing evolution' (Nelson & Winter, 1982, p. 371; Nelson, 1994). Indeed, in their original discussion, Nelson and Winter proposed an evolutionary organization-level approach to public policies while recognizing that the public-sector-specific path-dependent feedback environments lead to rather stable trajectories of policies and administrative systems:

At any time, public policies, like private technologies and policies, are implemented by organizations largely as a matter of organizational routine. Changes from existing routine usually are local, although there may be an occasional major change. Those changes may survive and take hold, or they may be turned back. Because a good share of the changes proposed are local and because the selection environment is comparatively constant, public policies tend to follow certain trajectories. Thus, a policy change today might fruitfully be understood as evolving from a policy base that was itself the outcome of a sequence of earlier changes, and, in turn, as setting the stage for future evolutionary developments (Nelson & Winter, 1982, p. 376).

Just as firms in specific countries, industries or systems of innovations tend to have different mixes of organizational routines, public-sector organizations may also need to have different organizations and diverse mixes of organizational routines to design and implement policies supporting innovation. Research on comparative capitalism and 'social systems of production and innovation' (Amable, 2016; Schneider & Paunescu, 2012) has tried to illustrate this argument on the level of national systems by arguing that different capitalist systems tend to have diverse institutional complementarities, including also specific roles for and organization of public policies. In organizational and public-management research, insights since Weber (1922; but explicitly also in Thompson, 1965; Wilson, 1966; Mintzberg, 1989; and more recently in Breznitz & Ornston, 2013; Tönurist et al., 2015) have made rather similar arguments regarding innovation in organizations: charismatic, entrepreneurial and professional organizations may be better at generating inventions and innovations than machine-like, production-oriented bureaucratic organizations, but the former may find it more difficult than the latter to diffuse and implement these innovations on a wider scale.

The crucial insight from the evolutionary theory is that the existence of desired institutional and organizational *complementarities* (assumed by most innovation-policy research, neo-institutional and comparative capitalism research, and also by the 'rational' policy and administrative analyses) between private- and public-sector organizational routines and capacities should not be assumed as a given. Search and selection processes and the selection and feedback environments tend to have significant differences between the private and public sectors and between policy domains. Thus, such complementarities emerge, if at all, gradually and through conflicts, mutual learning and adjustments or co-evolution (see Karo & Kattel, 2016a; 2016b).

As mentioned above, Nelson's *The Moon and the Ghetto* (Nelson, 1977; 2011) emphasized such differences and the uneven development of policy capacities across different policy domains (e.g. the 'moon and the ghetto problem' in the US), making the evolutionary argument relevant for a broader set of complex policy domains, as well.<sup>5</sup> He argues that one of the root causes of these differences stems from different *knowledge bases* that may dominate policy-making in different contexts and policy domains and determine the specific capacities that emerge. He differentiates between three bodies of knowledge, which tend to be unevenly distributed between countries and policy domains: '*rational*' *policy analysis of investments decisions* (policy capacity emerges from evidence-based analysis); *organizational and institutional knowledge* (policy capacity emerges from managerial skills and organizational management); and *scientific and technological knowledge* (policy capacity emerges from the application of scientific discoveries and technologies to policy problems).<sup>6</sup> Ideally, different knowledge bases should be complementary, but public-policy design and implementation may be driven by the dominance of one or some knowledge bases over others. This creates, in the framework of Wu et al. (2015), specific forms of political, analytical and operational capacities embodied in different types of organizations and routines.

Given these premises, the building blocks of the evolutionary theory of policy capacity look as follows.

*First*, public policies turn into reality (move from ideas to action) through *organizations* and their specific *routines*. These routines embody specific policy capacities (political, analytical, operational) that merge the individual and institutional/system-level capacities into unique *organizational configurations*.

*Second*, both the existing characteristics and changes in *exogenous factors* (economic and demographic changes, 'chance events' such as natural disasters and crises, dominant bodies of knowledge, invention of new technologies, changes in global regulatory regimes, political changes and policy and administrative reforms, changing 'user' demand) and *endogenous factors* (existing organizational routines and level of routinization in general; organizational changes driven by internal learning, competition, aging; organizational crises and conflicts) determine the specific organizational configurations and may trigger and direct or block *search and selection* processes for new organizational routines and new policy approaches.

*Third*, this search and selection takes place in the immediate *selection and feedback environment* that determines the *feasibility* of changing some routines or seeing new ones emerge. Given that public-sector organizations function in contexts of multi-level governance (with global and local interaction patterns) where 'economic' (market-, technology-, finance-driven) and socio-political feedback environments co-exist, often represent conflictual interests and are unevenly structured, the selection environment is characterized by *punctuated feedback* (see also Karo & Kattel, 2016a; 2016b).

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<sup>5</sup> He explicitly refers to research and development policy, innovation policy, educational and social policy and environmental policy (Nelson, 1977; 2011; Nelson & Winter, 1982).

<sup>6</sup> Of course, each of these bodies of knowledge has few or many competing schools of thought and traditions within it, which leads to debates and different views even within specific bodies of knowledge.

To sum up, from an evolutionary perspective, *policy capacities* – especially for innovation and other complex public-policy goals where uncertainty is the prevalent condition – a) are located, nurtured and routinized *within* organizations; b) are often dispersed into a *variety of organizations* within a system of organizations (policy domain); and c) evolve through organizational search and selection in the context of *specific punctuated feedback environments* of these organizations. In terms of Nelson's *The Moon and the Ghetto* terminology, policy capacities capture varying ways in which knowledge (expertise, skills, know-how, learning) is operationalized within policy making. Organizational and policy-domain specific differences in one or several of these elements lead to *differences* in policy capacities between organizations (even in the same policy domain) and policy domains (even in the same country).

### 2.2.1 Public-Sector Organizational Routines

The list of relevant organizational routines is open-ended, as it depends on the specific focus of the analysis in terms of task characteristics and environments (production vs. service organizations, policy design vs. implementation organizations in different sectors of activity carry out different tasks and build different routines). In the framework of Wu et al. (2015), not all organizations encompass and routinize political, analytical and operational capacities. As a result, the analysis of public-sector organizational routines is by definition exploratory and contextual. Two dominant perspectives emphasize different sets of activities that could in theory be routinized.

The *public policy literature* (Anderson, 2014; Wu et al., 2015) distinguishes different phases of policy-making with specific activities in each stage: *agenda-setting* (focusing of public attention on a specific problem); *policy formulation* (legislative, regulatory, programmatic strategies); *policy adoption* (decision-making processes); *policy implementation* (drafting of strategies, financing and control mechanisms); *policy evaluation and revisions*. From an evolutionary perspective, these stages cannot be easily separated even for analytical purposes, as the co-evolutionary changes are constant (implementation 'feeds back' to policy-formulation processes and triggers necessary revisions even before formal evaluations), and this is the most crucial characteristic of organizational activities and life. The *public-management literature* (see Pollitt & Bouckaert, 2011), which has many similarities with general management literature (Mintzberg, 1989), focuses on the key activities that determine how public-sector organizations function in different phases of policy-making: *organizational planning of structure* (size, forms of specialization, modes of coordination), *financial management* (budgeting, accounting, auditing), *personnel-management systems* (recruitment, career management), *performance management* (reward principles, accountability mechanisms). Importantly, while public-management research tends to predominantly conceptualize these at the system level (common institutionalized characteristics across different organizations), from the perspective of evolutionary theory, these activities could be indeed routinized, but potentially based on different knowledge bases, procedures and technologies – not only in different countries, or policy sectors, but also between different organizations (with different feedback environments) within a system.

One of the most fundamental issues in public- and private-sector organizational research on innovation seems to be how to maintain capacities for innovation and experimentation (search for



novelty) and capacities for efficiency (implementation of strategies and policies, delivery of goods and services) within an organization or specific system of organizations (the public sector in general or specific policy domains). As mentioned, the key insight from the evolutionary perspective is that *organizational variety* as a representation of different configurations of routines and capacities may be a necessary condition (Karo & Kattel, 2016b). These debates also highlight several crucial activities of organizations that could be routinized differently and lead to different policy capacities (innovation vs. efficient implementation). We can only provide a broad-brush description of some of these routines here, each of which is worthy of much more detailed elaboration and analysis:

- *Production routines*: what are the tasks of the organization (providing regulations, services, ‘things’) and how are the core and secondary or supportive functions organized (what is produced internally, what is contracted out and purchased in; what is co-produced)? These routines partly determine the structure, knowledge base and feedback context of the organization.
- *Strategic or dynamic managerial routines*: how is strategic planning and management organized (based on individual visions and open-ended experimentation vs. ‘rational’ top-down planning)? These routines partly determine to what extent the organization supports the search for novelty (providing incentives vs. punishing risk-taking and experimentation).
- *Personnel management and organizational learning routines*: what type of recruitment and motivation systems are preferred and what skills (bodies of knowledge) and values (risk-taking vs. predictability) are rewarded within the organization? How is learning and skill development organized (experimental organizational learning vs. policy emulation)? These routines partly determine the bodies of knowledge, policy orientations (and accepted policy rationales), accountability systems of organizations and behaviors of individuals in the organization.
- *Financial management routines*: how are organizational finances planned and managed (via legacy-driven line-item and incremental budgeting vs. more open and flexible systems), and what is the focus of auditing (procedural compliance vs. outcomes)? These routines partly determine the financial autonomy and risk-taking space of and in organizations.
- *Coordination routines*: how is vertical, horizontal and cross-system (between the public and private sectors or citizens) coordination organized (based on formalized rules vs. informal relations and networks) and what is *standardized* through coordination (inputs, processes, outputs, outcomes)? These routines partly determine the flows of information and feedback (content, speed, location), division of resources, speed and specificity of policy actions.
- *Research and development and technological routines*: what technologies are understood, used and developed by public-sector organizations? These routines partly determine the bodies of knowledge and routinization of search, but also the direction of the production, planning and coordination routines and the selection and feedback environments.

Following Wu et al. (2015), we can argue that some of the above routines are more or less related to political and policy activities, others to analytical activities and yet others to operational

activities. In the public-sector context, some of these activities are centrally routinized and institutionalized on the system level through laws, regulations, standards and norms, and organizations follow these routines (financial routines tend to be universal across organizations with similar budgeting and accounting rules). Other routines emerge and evolve in a much more organization-specific form (as organizations have more freedom in determining the content of, e.g., organizational learning practices or try to act against top-down standardization and routinization) and determine the specific capacities of organizations. Similarly, some tasks may be universally prescribed to organizations, but implemented through different routines.<sup>7</sup>

### 2.2.2 Search, Selection, Endogenous and Exogenous Sources of Novelty

From the evolutionary perspective, search and selection processes are highly open-ended, given that the search for novelty and experimentation happens in the context of uncertainty and is driven by the endogenous and exogenous factors of specific policies and organizations. Thus, search and selection are difficult to operationalize and model.

One might assume that in the public-sector context, search and selection are more ‘political’ and a question of conscious ‘choice’ than in the more competitive economic arena (Nelson & Winter, 1982). Given the punctuated nature of the public-sector selection and feedback environments, the factors affecting search and selection are often vague and conflictual. Search may be triggered by ‘user’ demand, mission-based collaboration between organizations, external political events (global agreements, regulations), chance events (natural and politico-economic crises) and politicized competition for organizational survival and resources. As a result, also the selection process does not function on efficiency or effectiveness grounds and through market-based competition, but has strong political and (non-rational) ‘choice’ elements. In their discussions on innovation in bureaucratic organizations, also Thompson (1965), Wilson (1966) and Mintzberg (1989) argued that while especially public-sector organizations are often analyzed through the lenses of cooperation, coordination and consensus-seeking, innovation in bureaucratic organizations is more likely to emerge through *conflicts* and *variety*. At the same time, they also recognized that too much variety may inhibit the eventual adoption and diffusion of policy and organizational innovations because the latter is inevitably a political and bargaining process.

Looking at the endogenous and exogenous sources of search and novelty creation, there may be individual-behavioral factors (charismatic leadership and entrepreneurship of organizational members), organizational routines-related factors (existence of routines for novelty search or organizational slack and space for non-routine search) and also external system-level factors (see more below) that could in theory influence how the search process is triggered, structured and evolves. Overall, this process is open-ended, uncertain and characterized by persistent conflicts, failures, learning and adjustments.

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<sup>7</sup> For example, most public-sector organizations contract out R&D and technological development (and thus such activities and related routines are hardly ever discussed in public-management research), while some maintain this as a routinized core organizational activity or competence. This creates different political, analytical and operational capacities regarding the use of technologies in public policies (see more in Lember et al., 2016).

### 2.2.3 Selection and Feedback Environments

The selection and feedback environments vary across public-policy domains and public-sector organizations, are multi-level (feedback has both local and global sources) and result in punctuated feedback processes. In other words, parallel and often competing or conflictual feedback environments affect the evolution of organizational routines and search processes in specific policy domains and organizations.

Understanding the structure and dynamics of feedback environments in a specific policy domain or organizational context is a crucial step for conceptualizing and defining organizational routines and search in a dynamic/evolutionary sense (that otherwise can only be described historically or as snap-shots). This is also crucial for conceptualizing policy capacity in an evolutionary sense, i.e. as providing *complementary* capacities to other actors. Some public-policy scholars (Wu et al., 2015) have also argued that stakeholder or system-wide capacities (see also Jayasuriya, 2005) are crucial elements of policy capacity (the public sector needs to fulfill tasks and functions not fulfilled better by others). In addition, modern research in the public sector and social innovation (see de Vries et al., 2015; Voorberg et al., 2015) argues that co-design, co-production and co-delivery are important factors in the public sector and social innovation. In other words, through a better comprehension of the dynamic feedback environments, we might gain a better theoretical understanding of the evolution of organizational routines, search processes and eventual capacities. This inevitably requires a rather interdisciplinary perspective and constant 'inlining' and 'outlining' of the environment where organizations function and evolve (thereby also constantly re-defining the core independent and dependent variables and context that can be assumed to be constant; see also Riggs, 1980).

In Table 1 we try to summarize the key elements of the selection and feedback environment in the case of public policies supporting innovation in markets (innovation policy). We highlight here three rather distinct selection environments – politico-administrative (focus of public management and governance research), politico-economic (focus of comparative capitalism and political economy research) and techno-economic (focus of innovation studies). These provide specific and often conflictual feedback to different organizations of innovation policy in terms of political-, analytical- and operational-level expectations and activities. This leads to punctuated feedback processes and subsequent search activities.

**Table 1. The punctuated selection and feedback environments of innovation policy**

<b>Capacities influenced</b>	<b>Politico-administrative feedback</b>	<b>Politico-economic feedback</b>	<b>Techno-economic feedback</b>
<b>Political capacities</b>	<p><b>Global</b></p> <p>Global rules and ideas of ‘good’ governance (e.g. as measured by the quality of governance indices; proposed by international organizations) (what are the ‘best’ ways to organize specific policy processes)</p> <p><b>Local</b></p> <p>Dominant political and ideological values (e.g. liberal vs. conservative), political decision-making traditions (e.g. authoritarian vs. democratic; majoritarian vs. consensual) and legal systems (public vs. common law)</p>	<p><b>Global</b></p> <p>Global rules and good practices of, e.g., trade, finance, corporate governance, intellectual-property management, membership in WTO or regional associations (what might be the ‘best’ policies from the perspective of industrial structure and firm interests)</p> <p><b>Local</b></p> <p>Dominant ideologies (statist vs. market-based vs. corporatist coordination and feedback networks; neoliberal vs. Keynesian economic policy), and regulatory systems of trade, finance, intellectual property (policy and negotiations ‘space’)</p>	<p><b>Global</b></p> <p>Characteristics of dominant (profit-accumulating) frontier technologies and structure of global production and innovation networks and value chains (what might be the ‘best’ policies from the technology perspective)</p> <p><b>Local</b></p> <p>Techno-economic specialization of domestic industry (at the uncertain frontier or in mature technologies or at the technology-importing stage) and global value chains (leader vs. follower, sub-contractor)</p>
<b>Analytical capacities</b>	<p><b>Global</b></p> <p>Dominant generic and policy-domain-specific (professional) ideas and more formal principles of policy-making and design (what are the ‘best’ practices of policy analysis)</p> <p><b>Local</b></p> <p>Policy-making culture (e.g. hierarchical vs. corporatist, or consensual) and institutions (e.g. strategic planning, production, coordination)</p>	<p><b>Global</b></p> <p>Dominant principles of state-market, state-society interactions (structure of consultation and participation systems); how to include business and industry interests in policy-design processes</p> <p><b>Local</b></p> <p>Structure and role of politico-economic feedback in policy analysis and planning; levels of trust and inclusion of stakeholders in policy design and planning (e.g. internal policy design vs. based on public-private interactions); stakeholder capabilities</p>	<p><b>Global</b></p> <p>Global principles and best practices of the role of the state in specific technology development (what are the technological-development-driven expectations on the role of the state in the context of technological uncertainty)</p> <p><b>Local</b></p> <p>Structure and role of techno-economic feedback in policy analysis and planning (e.g. high vs. low importance; generic vs. technology-specific analytics, learning and coordination)</p>
<b>Operational capacities</b>	<p><b>Global</b></p> <p>Dominant generic and policy-domain-specific (professional) ideas and principles of public management and policy implementation</p> <p><b>Local</b></p> <p>Existing administrative culture (e.g. legalist vs. managerial; generalist vs. specialist; top-down vs. bottom-up), institutions and routines (e.g. personnel and financial management)</p>	<p><b>Global</b></p> <p>Dominant practices of state-market interactions in R&amp;D and technology development processes (what are the standard divisions of labor between stakeholders in R&amp;D and innovation activities)</p> <p><b>Local</b></p> <p>Dominant feedback networks in R&amp;D and technology policy implementation and related division of labor (public-sector vs. market-driven vs. network-based systems)</p>	<p><b>Global</b></p> <p>Global technological standards and best practices in technology creation and diffusion, expected activities from the state in supporting R&amp;D and innovation</p> <p><b>Local</b></p> <p>Structure and role of techno-economic feedback in policy implementation (e.g. the role of the state in technology, research and development, technological skills and competencies of state actors)</p>

Source: Elaborated by authors (see also Karo & Kattel, 2014; 2016b).

The punctuated nature of the feedback processes affects the evolution of organizational routines and search processes of organizations functioning in a specific policy domain. Based on the broader (global, regional and national) structuring of the political systems (who has power and access) and existing organizational routines and capacities, organizations tend to react more to some feedback than others. For example, public universities are more likely to be influenced by global techno-economic feedback (as their mission is to function at the science and technological frontier), and they may not react as readily to domestic politico-economic feedback (to refocus research priorities towards domestic needs) or politico-administrative feedback (to reform university management based on some ideas of good governance).

Thus, the concrete tasks or missions of organizations in a specific public-policy domain influence the structure of the immediate feedback environment. This leads to differences in organizational routines, search processes and eventual political, analytical and operational capacities. As a result, in most policy domains we might find a variety of organizations with different mixes of routines and capacities (see Karo & Kattel, 2016b) that contribute – based on their specific capacities and in a co-evolutionary way – to the performance of the policy domain as a whole. For example, a recent large-scale meta evaluation (see MIOIR, 2013) of global innovation policy efforts highlighted that it is almost impossible to appropriate policy impact to single organizational activities (policy programs, measures, regulations). Rather, the impact of government activities on supporting innovation in markets can be, if at all, measured at the level of *policy mixes* designed and implemented by different organizations through co-evolutionary interactions.

In the next section we briefly illustrate these evolutionary dynamics through a stylized discussion of the evolution of STI policy capacities in three Asian ‘Tiger’ economies (Singapore, Taiwan, South Korea). While these countries have developed innovation policies in a relatively similar overall context of politico-administrative, politico-economic and techno-economic feedback environments, small differences in feedback environments have led to different policy capacities in specific organizations and national policy domains as a whole. We rely mostly on Wong (2011) and Karo & Kattel (2014; 2016b).

### **3 Punctuated Feedback and Evolution of STI Policy Capacities of the Asian Tigers**

Modern science, technology and innovation (STI) policies emerged in the Asian Tigers gradually from the 1960s to the 1990s as part of key strategic efforts to maintain national security and independence through export-oriented industrialization. The catching-up success of these economies throughout the period from the 1960s to the 1990s is something akin to ‘reaching the moon’ in the modern history of economic and industrial development. But one also has to recognize that for the main period of fast industrialization, the social conditions of the population – from democratic rights to labor conditions – were something one can describe as an ‘industrial ghetto’. And this partial failure to tackle social challenges led to social responses from the early to late 1980s that gradually tamed the developmentalist hearts of the Tigers.

In terms of the techno-economic selection and feedback environments, the Tigers had rather similar starting positions: natural resources were largely lacking, and techno-economic capabilities were specialized in eroding competitive advantages (in cheap labor-based and low

value-added activities of mature industries). This made it necessary to develop policies to overcome the declining cost-advantages via R&D and innovation (by developing basic human capital and technological capabilities). Also, on the politico-administrative side, the Tigers were rather similar: political systems where authoritarian, administrative systems had strong occupational and colonial legacies and an emphasis on merit-based organizations (though Confucian vs. Western legacies and politicization had different degrees of influence; see Drechsler, 2015). Crucially, the politico-economic selection and feedback environments were somewhat more diverse. In South Korea, the state had close ties with limited industrial conglomerates (*chaebols*). The Taiwanese political system maintained, at least initially, rather distanced relations with the private sector to limit the power and influence of the latter. As a result, a large state-led sector and a sector of more fragmented export-oriented small and medium-sized firms (SME) existed almost as parallel systems. In Singapore, the state built close ties with multi-national corporations (MNCs), partly for political concerns to control different ethnic groups and partly for economic reasons, as local industrial capabilities were weak. Overall, the links between the STI bureaucracy and the domestic public were largely missing and overlooked in all cases.

Thus, while STI policies had a common political logic (autonomy and security through STI) and policy 'rationales' (investment into STI to maintain competitiveness in export markets), the differences in the structure of politico-economic selection and feedback environments meant that the actual STI policies emerged in rather diverse forms. Using the terminology of Wong (2011):

- The strategy of South Korea was to 'go big': to support the large export-oriented and diversified chaebols in their in-house R&D and innovation activities through negotiating technology licenses from abroad, creating oligopolistic market regulations and using the nationalized fiscal and financial system (through the regulation of 'policy' loans and tax and tariff policies) to coordinate and focus firm-level strategies and resources for achieving critical mass in R&D and innovation.
- The strategy of Taiwan was (eventually) to 'go small': to support the export-oriented SME sector by socializing the R&D- and innovation-related and other risks of SMEs through a large-scale state-owned sector that used national research institutes to license in promising technologies from abroad, to develop and transfer them to firms that would further develop products for exporting.
- The strategy of Singapore was to 'go global': to create incentives for (through the provision of relatively cheap and qualified skilled labor and a stable political and regulatory environment) and actively target (through political efforts and an agile and flexible policy-making system) the relocation of MNCs (both the production and eventually their R&D activities) to Singapore.

As a result of these differences, the Tigers developed different types of policy capacities through diverse configurations of organizational routines. All countries established high-level policy coordination bodies to coordinate national strategic choices (economic development boards) that were supported by different ministries, regulatory and financing agencies, research organizations and state-owned enterprises. Given the differences in the actual strategies, the analytical and operational routines and capacities of these organizations differed quite markedly.

For example, the direct involvement of the Taiwanese government in planning and conducting R&D meant that the strategic planning, production, coordination and R&D routines of government organizations were explicitly technology-focused: the government did not just decide to regulate, incentivize and fund R&D in general, while allowing universities and firms to decide what to focus on and when, but steered their technology-creation processes much more directly. This also required more technology- and engineering-focused recruitment and training routines in all public-sector organizations (see Breznitz, 2007). At the same time, the South Korean STI policy has followed a more generalist and hands-off approach. As a result, its key STI policy organizations developed routines to incentivize private R&D activities via market and financial-system regulation (who can enter specific markets and on what condition; to whom banks lend money), informal coordination and steering. Both of these approaches were somewhat unorthodox in terms of the emerging 'best practices' in the global techno-economic, politico-economic and politico-administrative feedback environments. Singapore's strategy was probably the closest to these 'best practices'. As their growth performances between 1970 and 1990 indicate (see Sen, 2013), the Tigers were some of the best-performing economies in this period and also became important technology hubs in ICT.

As Wong (2011) argues, however, this development path was relatively simple and straightforward, at least compared to the key challenge of modern STI policies: to shift from *mitigating risks* in relatively mature industries in catching-up phases to *managing uncertainties* in new and emerging technologies at the techno-economic frontier. In other words, the immediate techno-economic feedback environments have become more uncertain. For example, biotechnology – one of the new potential global drivers of economic and social development and a common policy priority in all Tigers and globally – is still emergent, science-based (it lacks established technologies that could be easily licensed from others, as was the case with ICT-based development), and it also lacks established pathways (business models) to success. Furthermore, the politico-administrative selection and feedback environments of the Tigers have become more complex: all countries have democratized, and political competition for resources has increased; integration to global networks has meant that their rather unique development-focused administrative systems are pressured to converge with global 'best practices'. The politico-economic selection and feedback environment is changing, as well, as the export successes of these economies have allowed their companies to become increasingly integrated into global production and innovation networks and value chains. This has often made the transnational governance of these value chains a more influential feedback source on firm behavior than local policies (Yeung, 2013). As a result, politico-economic selection and feedback systems have also become more uncertain, contested and globalized.

Such growing complexity and uncertainty would require the search for new policy and organizational routines – or innovation in government policies, services, institutional and organizational designs. From the evolutionary perspective, in the context of such uncertainty, these search and selection processes happen in a highly open-ended, conflictual and punctuated way. Initially, all Tigers opted to strategically prioritize biotechnology (as the next globally fashionable bet), as opposed to entering policy- and governance-related search processes. And the first reaction of organizations tasked with biotechnology STI policies was to stick to the historically successful policy and governance strategies of going 'big', 'small' and 'global' respectively. The broader shifts and increasing uncertainties in the selection and feedback

environments have meant that the desired policy outcomes (increased biotechnology-related STI capabilities and exports; more systemic socio-economic changes) have been rather slow to emerge (see further case studies on Taiwan and Korea by Wang et al., 2012; Zhang & Whitley, 2013). The new organizational routines and configurations of the biotechnology STI policies have to emerge through a long-term, conflictual and punctuated process of search and selection. To support biotechnology STI, more actors – ministries and agencies for agriculture and health – need to be incorporated into the STI policy arena, and some of them may need to be reformed (in terms of their organizational routines) for such new roles. For example, in the case of Taiwan, Chung (2011) has documented in great detail how there have been significant discrepancies between the traditional STI policy and the health and environmental regulatory activities, as the regulatory agencies are new to the STI policy arena and have different policy routines and capacities (they take fewer risks and are less experimental). Further, concerns other than economic policy rationales – ethics and politics of biotechnological innovation – also need to be internalized and managed by different organizations tasked with supporting biotechnology.

The conventional analytical approach to STI policy seems to diagnose this situation as the ‘weakening’ of policy and coordinative capacities (also explicitly in Wong, 2011). From the perspective of the proposed evolutionary analytical framework, we should treat this as a rather normal contested and punctuated process of search and selection in policy and organizational evolution. It may succeed or fail (in terms of supporting technological and economic development), given the endogenous and exogenous factors affecting the search and selection of new policy and organizational approaches. Smart innovation policies that seek to steer innovation processes into new directions take this account and try to prevent systemic policy failures by designing context-specific solutions that allow organizations to read their feedback environments, experiment and fail with different solutions and learn from their successes and mistakes. In other words, they trigger evolutionary search and selection.

In more recent years, both South Korea and Taiwan have sought to rethink their development strategies. National strategies and organizational reforms have sought to shift from predominantly industrialization- and technology-driven logics towards a more fundamental rethinking of development paths by introducing new narratives and redesigning policy and organizational systems to link the technological ‘moonshots’ (in biotechnology, new energy technologies, robotics, AI, etc.) not only with GDP growth, but to steer STI and industrial innovation towards more socio-economic goals and tackling societal challenges from quality of life to sustainable development (see more in Karo, 2018).



## 4 Conclusions

Modern STI policies have become increasingly politicized: innovations need to take us back to the moon and find solutions to the complex problems of ghettos and rainforests. This requires both technological and social innovation but our governance systems seem to be rather bad at delivering both in a complementary way. Therefore, rethinking of economics, politics and governance of innovation should be of utmost importance for innovation scholars and studies.

As for our contribution, we have proposed an evolutionary analytical approach to policy capacity with a specific focus on policy domains where uncertainty and the need for policy innovations, or novelty creation, is central. From an evolutionary perspective, the crucial conceptual elements for comprehending and analyzing policy capacity are: a) organizational routines, b) search and selection processes and the endogenous and exogenous sources of novelty creation, and c) selection and feedback environments.

Through the concept of routines, we have tried to conceptualize policy capacity from a less static and normative perspective than usually found in public policy and innovation policy studies. From an evolutionary perspective, *policy capacities* – especially for innovation and other complex public-policy goals where uncertainty is the prevalent condition – a) are located, nurtured and routinized *within* organizations; b) are often dispersed into a *variety of organizations* within a system; and c) evolve through organizational search and selection in the context of the *specific and punctuated selection and feedback environments* of these organizations. *Differences* in policy capacities between countries, policy domains and organizations to tackle the most complex socio-economic challenges stem from differences in the dominant organizational routines, related search and selection processes and/or in selection and feedback environments. A comprehensive analysis of policy capacities should encompass all these elements. Although this is a complex and interdisciplinary task, the ghettos and rainforests deserve this.

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