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Governance of Regional Innovation Systems: An Evolutionary Conceptual Model of How Firms Engage

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Abstract

This paper draws upon insights from social science, in order to propose a conceptualization of the governance of a regional innovation system. We are specifically interested in ones initiated through public policy and aiming to stimulate the competitiveness of firms through developing new technological knowledge through collaborative research involving different organizations. We are assuming firms choose whether, when and how to collaborate.

This paper proposes a conceptual model, which focuses upon the governance processes at the regional level of this translation of knowledge into innovation and entrepreneurship. The underlying argumentation for the model is built from existing research. We interpret that regional innovation governance depends upon capacity building among three heterogeneous organizations ? namely university-government-industry. This represents a case of a polycentric, adaptive, complex and self-organizing system, whereby collective action is supported by norms and institutions in order to develop a region resource pool. Hence, our expectation is that our conceptual model will help explain why different outcomes are possible. The concluding section discusses a future research agenda, by going further to explore how to define and analyze the attributes (mechanisms) enabling governance of a regional innovation system as well as to analyze how public policy and firms engage

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Key words: Governance, Regional innovation system, Innovation management, Collaboration

1. INTRODUCTION

The conceptualization of governance is an important topic across the social sciences. Recent literatures in fields ranging from management and political science to regional studies and policy studies define and analyze governance, in a variety of ways, using different theories, concepts and methods. Therefore, an aim of this paper is to explore discourses from other fields, in order to enrich an understanding of a significant management issue, namely collaborations around technological development.

This paper conceptualizes governance in the context of a particular type of emerging, adaptive, complex systems, namely the governance of regional innovation systems. Due to the relationships between knowledge and capabilities in organizations in the process of turning ideas into business innovation, firms have an incentive to choose to be involved in collaborative technological development. Governance in this particular situation is difficult due to the particular characteristics of knowledge and information. The conceptual model proposed here helps specify how and why collective action – involving norms, institutions and organizations – leads to a common resource pool and path-dependency. Our proposition is that the scientific and technological knowledge created regionally forms a common resource pool, and this pool is created and maintained by the actors participating as a form of collective action. Depending on how the attributes (mechanisms) play out, governance can lead to positive or negative outcomes, in relation to business innovation.

Theories of governance can be seen as closely related to theories of complex, emergent systems, especially when explaining technological change. Some lines of research focus upon the regulation of new technologies (Marchant, Abbot and Allenby 2014), while others focus upon the complex roles of governance in regional development (Karlsson, Johansson and Stough 2013). Complex system thinking has

also influenced public policy, especially as an alternative to the economists' view that public policy should (only) be in response to market failures (Arnold et al 2003).

During the last decades, many public policy initiatives to promote growth have focused upon the regional agglomeration of human capital. Many of these policies have been inspired by normative models, specifically models of systems of innovation, regional innovation systems, triple helixes, and industrial cluster policy (see for example, Edquist 2006; Ashheim and Gertler 2005; Asheim, Cooke, and Martin 2006; Eztowitz 2008). This focus on developing public policy initiatives to stimulate economic growth and societal well-being was underpinned by advances in economics, which increased our understanding of the special role of technological and scientific knowledge in economic growth (Romer 1986; Nelson 1996). Later, literature developing the concept of innovation systems has stressed the importance of institutions, networks and knowledge bases at the regional, sectoral and national levels (Malerba 2004; Edquist 2006; Lundvall, Johnson, Andersen and Dalum 2002; Cooke, Gomez Uranga, and Etxebarria 1997; Nelson 1993; Edquist and McKelvey 2000; McKelvey 1991). Indeed, theories of governance and systems have become increasingly relevant in discussions about innovation and economic emergence (Harper and Lewis 2012; Foster and Metcalf 2012), and gained momentum after the 2008 crisis (Coen and Roberts 2012).

Typical actors identified as important in stimulating technological development in regions include universities, industry and government. The most important mechanisms within firms and innovation systems are the institutional arrangements related to translating knowledge and R&D into business innovation and knowledge intensive entrepreneurship (Audretsch and Keilbach, 2007; Dodgson, Gann and Salter 2008; Malerba, Caloghirou, McKelvey, and Radošević 2015).

Moreover, from the broader discourse on governance, it is clear that some type of governance is needed to manage this particular type of complex system, and related public policy. Within political science, the concept of 'governance' has been developed in order to capture the governance of civil society, which is not entirely regulated through the market or through the government. Governance is seen as a new way to solve grand societal challenges, given that neither the liberal market approach, nor the traditional top-down government steering approach are seen as good models of effective management solutions (Jessop 1997; Voss et al. 2005; Loorbach 2010). The government should no longer be solely seen as deciding upon rules and implementing policy initiatives.

Within political science and economics, new models of governance are being proposed, whereby public policy facilitates processes of governance amongst diverse actors. The work of the Ostroms' and colleagues on governance has affected the discourse on public policy also. The main theoretical insight from the Ostroms' work is that different sets of self-regulating norms and institutions amongst the participants can be developed collectively, and be self-organized. Moreover, there is a dynamic component in that the exact constitution of these norms and institutions will have impacts on outcomes, and may help to predict why economic systems tend towards different positive and negative outcomes (Ostrom, Gardner, and Walker 1994).

Therefore, this paper draws upon insights from relevant theory in a range of fields, in order to propose a conceptualization of one type of governance, e.g. the governance of a regional innovation system. We are specifically interested in ones initiated through public policy and aiming to stimulate the competitiveness of firms through developing new technological knowledge through collaborative research involving different organizations. We are assuming firms choose whether, when and how to

collaborate in this particular type of regional innovation system. Moreover, our starting point that firms are involved in a regional innovation system, which involves public-private interactions through networks of relationships, collaborations and partnerships to stimulate technology at the regional level.

The dynamic, evolutionary perspective developed here as part of our model suggests that either a positive or a negative outcome can be expected, and possibly neither predicted, a priori, because the actual outcome will be impacted by the arrangement of the innovation governance in a particular region and technological field. Hence, our expectation – to be developed in a future research agenda – is that our conceptual model will help explain why different outcomes are possible. The identified attributes in the model should impact outcomes. In positive terms, a well functioning governance system will exhibit more success (measured in terms of likelihood to innovate) as well as affect the directionality of the technological knowledge (measured as specialization in the type of technology shared amongst actors in a region). This expectation is based upon our understanding that the translation of knowledge into business innovation and entrepreneurship should be seen as a special case of a process of economic emergence. This process involves variety creation, the building of resources and capabilities, and selection over time, in a process involving multiple organizations and distributed innovation systems involved in governance.

Section 2 provides an overview of the theoretical background, through insights from three streams of relevant literature. The first stream of literature explains polycentric systems of governance and tragedy of the commons (social dilemmas) from political science and economics. This is useful to establish that multiple actors can develop self-regulating norms, and how organizations participate in such systems. We then turn to literature addressing regional development, innovation governance and the role

of regional public policy, to focus more upon this particular type of system. The third stream of literature is evolutionary perspective on economics and firm theory, which provide a better understanding of how innovation systems may affect the regional development of capacities to innovate.

Section 3 provides a definition and the conceptual model, including the linkages between collective action, regional resource pool and trajectories of path-dependencies. Our model can be used to define the attributes (mechanisms) enabling governance of a regional innovation system as well as to analyze how public policy and firms engage.

Section 4 provides a research agenda, through the discussion of a series of topics for further study. These topics related to firms and public policy, in that norms, institutions and organizations are involved in creating and maintaining the common capacity to innovate at the regional level.

2. EXPLORING DISCOURSES IN RELEVANT LITERATURE

2.1 Polycentric Systems of Governance as a Solution to Tragedy of the Commons (Social Dilemmas)

This first stream of literature explains polycentric systems of governance and tragedy of the commons (social dilemmas), drawing upon political science, economics and regional studies. Empirical studies of polycentric systems have been critical for the development of governance theory. A key contribution of this literature is how the development of institutions and norms are needed, in order to avoid a tragedy of the commons as well as lead to positive outcomes for all actors involved.

Polycentric systems can be seen as complex systems of governance, because they consist of many decision centers, each having restricted but autonomous claim, but nevertheless operating under a common set of norms or rules (Aligica and Tarko 2012). The definition of *polycentric* is that there are many organizations and/or decision centers involved, that are formally autonomous, but are in fact linked together by an overarching set of rules, networks and relationships (Polanyi 1951; Ostrom 1972, cf. Aligica and Tarko 2012).

Seminal work was done through a series of case studies of reform in American metropolitan areas, in studies headed by Vincent and Elinor Ostrom. In particular, the Ostroms showed that more complex metropolitans had systems of relationships between local government units, public agencies and private businesses that “create important economic opportunities and evoke self-regulating tendencies” (Ostrom and Ostrom 1965: 135-136).

In contrast to what might be expected, these complex, polycentric systems of governance outperformed the less complex ones every time (Ostrom et al. 1978), due to a combination of different components and social mechanisms. In the later works of Elinor Ostrom, she focused on identifying the members, rules and norms that were in place to regulate access to information and resources (Ostrom 1990: 2005).

The discourse on social dilemmas proposes that actors can use these norms and institutions, and thereby develop collective action, in order to avoid negative outcomes. Indeed, the types of governance proposed in the work by Ostrom suggests that collective action can lead to positive outcomes, without a formal and centralized decision-maker. This can be seen as a solution, and in contrast, to an earlier concept, that of a tragedy of the commons (Hardin, 1968), such as overgrazing on common lands and pollution.

In a parallel theoretical development, Robert D. Putnam developed his theory of social capital. His theory should explain how the general public may (or may not) interact at the local and regional government level, and also the impact of their participation on successful institutional performance, depending on norms, civic networks, and diffuse relationships of interpersonal reciprocity and trust (Putnam, 1993). This relates to a line of earlier literature. White (1981) addressed norms underlying the formation of markets. According to Coleman (1990: 251), norms arise when “an action has similar externalities for a set of others, yet markets in the rights of control of the action cannot easily be established, and no single actor can profitably engage in an exchange to gain rights of control.”

This view means that to function positively, these kinds of complex organizational systems are dependent on social and political capital. Empirical work also suggests that social and political capital matters for regional policy, especially when it is based on a commitment to core values, informal but dense local and regional networks, and sporadic global relationships (Szücs 1995; Wise and Szücs 1996). Governance may also lead to system transitions, such as sustainability. Voss et al. (2005) and Loorbach (2010) propose that studies of governance can be used to explain how and why different organizations – based on different logics and attributes, but who share a common pool of resources – may develop effective governance for sustainability.

Hence, this literature focuses the conceptualization of governance upon how actors can set up a framework of self-regulating rules and institutions to prevent free-riding, and prevent a subsequent “tragedy of the commons” (Hardin 1968, cf. Ostrom 1998). In our case, we are therefore interested in collective action, norms and institutions that are set up the regional level, involving public and private actors investing and developing technologies.

2.2 Innovation Governance and Public Policy

This section turns to theories, which are more specifically focused upon innovation governance and public policy in regional development.

Various studies demonstrate that the genesis of innovation and entrepreneurship can be found through the emergence of knowledge processes related to actors and capabilities, which start at the local and regional levels (Saxenian 1996; Klepper 1996). Thus, this governance will tend to take place around a cumulative pathway of developing regional capabilities within specific technologies and industries. Previous research has stressed the development of regional competencies, as part of a global economy, in these heterogeneous networks supporting innovation and entrepreneurship (Cooke and Piccaluga 2004; Brink, Dahlander, and McKelvey 2007).

In particular, the approach known as evolutionary economic geography is relevant here (Boschma and Frenken 2006; Boschma and Martin 2010; Boschma 2012), and is highly related to the theoretical discussion in the next section. Holmén and McKelvey (2005) propose that this evolutionary approach can be used to analyze the accumulation of capabilities within specific technologies and regions. Important ideas in this type of economic geography stress the particular role of knowledge, networks and individuals to link different geographical spaces (Bathelt et al 2004) and the accumulation of particular sorts of knowledge and industries in regions (Asheim et al 2006; Cooke et al 1997). A key finding of this literature is that regions tend into what is known as 'path-dependencies', or cumulative specialization of technologies and industries over time.

According to Kuhlman (2006: 21), the innovation governance approach allows one to analyze “diverse but interdependent arenas” in which actors are “developing, negotiating and deciding public and private innovation policies”. Kuhlmann (2001) discusses innovation policy, and its impact on different systemic outcomes. Cooke and Morgan (1998: 33) propose that a similar concept of what they call the “associational economy”, which is dominant for innovation, including an “ensemble of relations in which firms, states, and systems interact.”

In policy studies, more complex views of governance have thus been developed, even though they at times have difficulties making their voices heard in an era of new public management, which stresses distance, accountability and additionality (Rhodes 1997; Georghiou 2002). Still, as applied to the development of technological knowledge, we can logically explain why and how the concept of governance of complex systems is an alternative to the economists’ view of market failure as a rationale for policy.

On the one hand, from a market failure perspective, public policy should intervene to stimulate the development of scientific and technological knowledge, only when firms do not invest. Even then, a critique has been that policy-makers are not better decision-makers than firms and may waste money (Lerner 2009). Due to the particular nature of knowledge as a public good, this type of investment will have spill-over effects that are vital for the economy. Standard public policy for many decades has been to invest in basic research and universities, subsidize firm R&D, etc.

On the other hand, from the perspective of the governance of complex systems, this investment by public policy does not by itself stimulate economic growth. It may be a necessary but not sufficient condition. Developing and accessing technology under conditions where society lacks associated institutions and network structures, or with

poorly performing ones, does not *a priori* make the firms more competitive or more innovative – nor does it turn under-performing regions into Silicon Valleys (Braunerhjelm and Feldman 2008). Whether the outcome is positive or negative depends, however, on mechanisms related to governance amongst the different actors involved.

Indeed, several studies exist of the governance structure of regional innovation systems and of science policy. One issue studied is which processes lead to failure, rather than success, with the idea that public policy can be targeted to mitigate failures. Arnold et al (2003:6) draws upon existing literature to suggest that innovation systems can fail for the following four reasons: 1) Capability failures. These relate to inadequacies in potential innovators' abilities to innovate; 2) Institutional failures. This refers to failure to (re)configure societal institutions; 3) Network failures. These are problems which arise in the interactions among actors in the innovation system; and 4) Framework failures. These include regulatory frameworks, health and safety rules etc. as well as other background conditions, such as the sophistication of consumer demand, culture and social values. Perry (2007) examines multi-level governance in England in relation to science policy, by focusing upon the rise of regional science policies, which are constrained by governance structures, frameworks for action and dominant policy discourses.

Another key issue studied is a specification of variables that affect the ability of the public sector to coordinate such diverse and complex processes as technological development. Kitagawa (2007) examines the transformation of Japanese innovation system from a centralized one to one focused upon regional clusters. Analytically she studies how the policy instruments used, their impact on regional economic development, organizational embeddedness in regions and the ability of regions to

coordinate innovation support policies enabled this transformation. Edler and Kuhlmann (2008) examine the fragmentation of the German research and public knowledge system. Their analysis focuses upon the challenges of coordination which are involved with fragmented systems. Under such conditions, an important understanding of coordination relates to attempts to improve coherence and to provide overall orientation through means such as (limited) disentanglement of responsibilities, strategic, cross-cutting initiatives, and the usage of standards, evaluation and advisory bodies. Nilsson and Moodysson (2014) analyze public policy in southern Sweden, in relation to the coordination of regional innovation systems. They argue that these regions face three generic problems, namely, lack of resources (e.g. human and financial capital), negative lock-in (e.g. to historically strong sectors), and fragmentation of actors and activities.

Hence, within economic geography and policy studies, the discussion of governance has been focused upon innovation governance, and often upon the particular rationale, role and impact of public policy. The above reasoning suggests that public policy can also impact regional development, through initiating the embryo of a new governance system, or by changing an existing one. Public policy tends to work through coordination mechanisms, which may in turn indirectly affect norms and institutions across different types of actors in the regional innovation system. Moreover, regional specialization will likely arise, in what is known as ‘path-dependencies’, or cumulative specialization of technologies and industries over time. This is closely linked with the following discussion.

2.3 Evolutionary Perspectives

This third stream of literature draws upon evolutionary perspectives, from evolutionary economics and evolutionary theory of the firm. These theories help explain why firms may engage in collective action, thereby linking the firm to the external context through innovation processes. Moreover, the discussion further develops our dynamic process perspective, leading to possible path-dependencies, or differing outcomes of the system over time.

Continuing on the above focus on the role of policy in impacting firms' decisions, we should point out that the evolutionary perspective can be contrasted with common concepts in economics, in order to understand the rationale and interpretation of actors' investment and development of knowledge. From an economist's perspective, one characteristic of information is 'non-rivalry', meaning that one person's use does not prevent (or diminish) another's use of the same knowledge. This enables spillovers from one party to another and stimulates overall societal benefits, in the long run. Another characteristic is non-excludability, which means that once the information is created, others can gain access it, and knowledge becomes diffused. Hence, the classical analysis in economics is the appropriability problem, e.g. firms will have an incentive to under-invest in developing more information (because they cannot appropriate all the returns) and therefore government should invest in basic science.

Within evolutionary approaches to the economy and the firm, it has been recognized that government investment in basic science and firms' ability to appropriate the new knowledge they develop are a necessary but not sufficient conditions for analyzing economic growth (Winter 2006). From this perspective, both characteristics of non-rivalry and non-excludability are tempered by the need for the firm (or other actor) to

have internal capabilities to develop and monitor external knowledge flows, or what are known as absorptive capacities (Cohen and Leveninthal 1990). The firms' characteristics and the internal capabilities will therefore affect whether technological information and knowledge are used, or not, in innovations as well as which parties are willing to invest or not in developing additional new knowledge.

One therefore needs to understand how firms engage in collaborative action around knowledge, and emergence tends to follow particular paths of development. At the systems level, this is called economic emergence. Emergence is qualitatively different from spontaneous order, because “the type of process through which states of affairs or institutions arise and, in particular, to the possibility of self-organising systems in which order arises without being consciously designed” (Harper and Lewis 2012:335). Foster and Metcalfe (2012:424) focus upon what they call ‘strong’ emergence properties “that give rise to, for example, irreducible systems that are the outcome of Schumpeterian radical innovation and associated entrepreneurship.”

Schumpeter (1943) was one of the first economists who highlighted the role of innovation and entrepreneurship in the economy. Innovations, or new combinations, can consist of a) new goods or new qualities of a good; b) new methods of production; c) opening of new markets; d) new sources of raw materials; and e) new organization of an industry – e.g. industrial dynamics.

Therefore, the innovating economy should be understood as involving continual renewal (and creative destruction) of the economic structure, involving new combinations of resources and capabilities (McKelvey and Holmèn 2006). Over time, these processes enable a recombination of resources and capabilities, in order to deliver existing goods and services, and also generate new combinations as well as routine (Nelson and Winter 1982).

Innovation systems became one way to capture the underlying mechanisms tying knowledge to growth and competitiveness, especially at the national level (Edquist and McKelvey 2000; Nelson 1993; Lundvall et al 2002). This approach provided a different explanation of economic growth, but was triggered by advances in economics. From the 1970s and on, significant empirical evidence and theorizing in economics indicated that knowledge is vital – and also rapidly gaining in importance – as the major driver of both innovation and economic growth (Rosenberg 1972; Romer 1986; Nelson 1996).

Because science, technology, innovation and entrepreneurship play key roles in renewing the economy, these emerging complex innovation systems mediate firms' behavior. According to some streams of literature, innovation systems can therefore be characterized as a distributed emerging system involving knowledge, whereby firm capabilities must also be conceptualized as being created across, or between, different organizations (Coombs and Metcalfe 1998).

Firms' actions are key, yet underexplored in this literature (McKelvey 1996), and therefore we should turn to literature in technology and innovation management, especially those with a dynamic, evolutionary perspective. Similarly, the processes underlying university-industry interactions do not just automatically turn scientific results into new products and processes or new companies (Perkmann et al 2013). Instead, there are complex, historical processes, involving individuals, organizations and institutions in the two processes of commercialization of science and academic engagement with industry.

Innovation management has demonstrated how and why firms are engaged in developing knowledge relevant for business innovation through collaboration (Dodgson et al 2008; McKelvey 2014). Recent concepts such as open innovation, and

user-driven innovation indicate why and how firms must collaborate to develop ideas and to innovate commercially (Chesbrough 2003; von Hippel 2005). De la Mothe (2001: 10) argues that “governance is about handling of complexity and the management of dynamic flows. It is fundamentally about interdependence, linkages, networks, partnerships, co-evolution and mutual adjustment.”

Particular foci are upon the role of networks, which allow firms to access knowledge resources and capabilities from co-inventing with a diverse range of actors (Dodgson, Gann and Phillips 2014). Networks are also related to technological knowledge in terms of facilitating its production and use. The network ties arrangements may be envisioned as informal ties between individuals (Granovetter 1985; Uzzi 1996), formalized strategic alliances between organizational actors (Eisenhart and Schoonhoven 1996; Powell, Koput, Bowie and Smith-Doerr 1996; Owen-Smith and Powell 2004) or as interlocking connections between firms and individuals (Davis, Yoo and Baker 2003).

A related finding is that networks may have impacts on a later phase of firm history. In particular, the networks of the founders have been shown to influence the entrepreneurial firm’s initial endowment of resources. Empirically, one can also see that success in knowledge-intensive entrepreneurship is largely determined by what is known as its pre-history and the knowledge endowments of those firms (Carroll, Bigelow, Seidel and Tsai, 1996; Helfat and Liebermann 2002; Giarratana and Fosfuri 2007; Zaring and Eriksson 2009). The existing networks also determine the firm’s choice of organizational identity, entry strategy as well as its future ability to access new resources as the need arises (Dobrev, Kim, and Hannan 2001; Hsu and Hannan 2005).

Hence, the evolutionary perspective in economic and theory of the firm is useful here, to help explain why firms engage in collaboration, as necessary to innovate, and are impacted by the context and networks, over time. By collaborating and developing self-regulating networks, this leads to what is known as emergent properties of the economy, and can lead to path-dependencies. A variety of changes will occur externally to the firm, due to what is known as Schumpeterian radical innovation and associated entrepreneurship. Firms must then adapt. This section thus focuses our attention upon processes, which inherently lead to continuous novelty change and selection, as well as processes of replication and repetition of existing routines and norms.

3. CONCEPTUAL MODEL: GOVERNANCE OF REGIONAL INNOVATION SYSTEMS

This section builds upon the streams of literature discussed above, to enrich an understanding of a significant management issue, namely collaborations around technological development. Section 3.1 outlines the specific characteristics of our case while Section 3.2 provides the model, including visualization and a description.

3.1 Specific characteristics of our case of governance

The challenges of governing the type of complex systems analyzed in this paper have to do with the particular characteristics of knowledge and information, and their relationship to turning ideas into business innovation within firms.

Governance is a process of developing norms and institutions across diverse organizations, and polycentric systems may be very efficient. In our specific case, the

organizations identified collaborate around specific technological areas and goals, and as such, the actors can engage in collective action by creating overarching rules and goals, or norms and institutions. Firms and other organizations in regional innovation systems, involved in collaboration, may therefore need to set up of the type framework discussed previously, namely self-regulating rules and institutions to prevent free-riding, and prevent a subsequent "tragedy of the commons" (Hardin 1968, Ostrom 1998).

Given the characteristics identified previously, knowledge and information can be seen as a type of public good, which affects firm behavior, and willingness to invest in technology and to collaborate. In economics terms, information has particular characteristics related to the appropriability problem, namely non-rivalry, non-excludability, and the existence of spill-overs. Innovation management has demonstrated that firms must collaborate to innovate, especially for knowledge and technologies. Therefore, given the collaborative nature of innovation, we can use the previous work on governance, in order to conceptualize that collective action can lead to a resource pool can be created amongst actors. Organizations should benefit by actively collaborating, given that firms need absorptive capabilities to interpret and apply this knowledge to innovate through products and services.

These specific characteristics opens up the need to analyze many interesting questions about governance, as related to the access, use and benefits to firms, and especially under weak appropriability regimes or under open innovation contexts (Winter 2006; Teece 1986). Knowledge as a common resource pool will be accessible to more actors than those who invested in creating it in the first place. This resource pool may be accessible to actors that do not have the intention of maintaining its existence, and which are not its intended beneficiaries.

Existing literature on regional innovation systems suggests that the three organizations of university, industry and government are vital, in developing regional capabilities. The differences in incentives and institutions between basic research and company innovation was outlined already in Dasgputh and David (1990). Scütz, Zaring and McKelvey (2012) as summarized in Table 1, specifies how and why the three types of organizations involved in regional innovation systems have different incentives while engaging in discovery and diffusion of knowledge, and different networks.

Table 1: Incentives and networks of organizations involved in regional innovation systems

	<i>University</i>	<i>Firm</i>	<i>Government</i>
<i>Norms/Incentives</i>	Truth and knowledge-seeking	Maximizing economic profit	Gaining/maintaining political power
<i>Network</i>	Scientific community	Industry	Civic society

Universities have an incentive to develop new knowledge and to diffuse through teaching and other interactions with society, with a main network in the scientific community. Industry has an incentive to maximize economic profit, with the main focus of their network with other firms. Government has the incentives to gain and maintain political power, with the main network civic society.

Therefore, given this diversity, we suggest that a key focus of governance of regional innovation systems must be upon how different norms, institutions, and organizations can create ‘common’ rules for regulating development and access to that new knowledge, and to partners through networks.

Indeed, the existence of common rules also suggests that linkages or channels between actors must be formed as well, to facilitate the transfer and translation of knowledge. Innovation management predicts that several important mechanisms exist, to enable actors to be involved and to benefit from new knowledge, as discussed above. This paper has identified public-private interactions through networks of relationships, collaborations and partnerships to stimulate technology at the regional level.

There are also issues to study about the relationship between overall system governance and the role of public policy, given our focus upon emerging complex systems which were initiated by public policy. When public policy is involved in relation to knowledge, there is often a public investment into the development of knowledge. All governments support research – scientific, medical, engineering, social science and so forth – with the idea that in addition to being cultural heritage, the resulting knowledge will be useful in some way to society in the future.

Within science policy, the most relevant example of a possible conflict in a polycentric system is the intersection between publically funded science with academic entrepreneurship through companies and patents. This is an old debate with the scientific community, and criticisms against privatizing public science took off again in the late 1970s when biotechnology began to be commercialized within medical schools (McKelvey 1996), but later died out as many university scientists in these fields became academic entrepreneurs. Later, of course, the whole discourse has flipped, whereby the discourse today is that public science should be privatized through academic patents and start-up companies. How actors develop the norms and institutions needed for university-industry interactions is a research question still being explored (Perkmann et al 2013; Perkmann and McKelvey 2012).

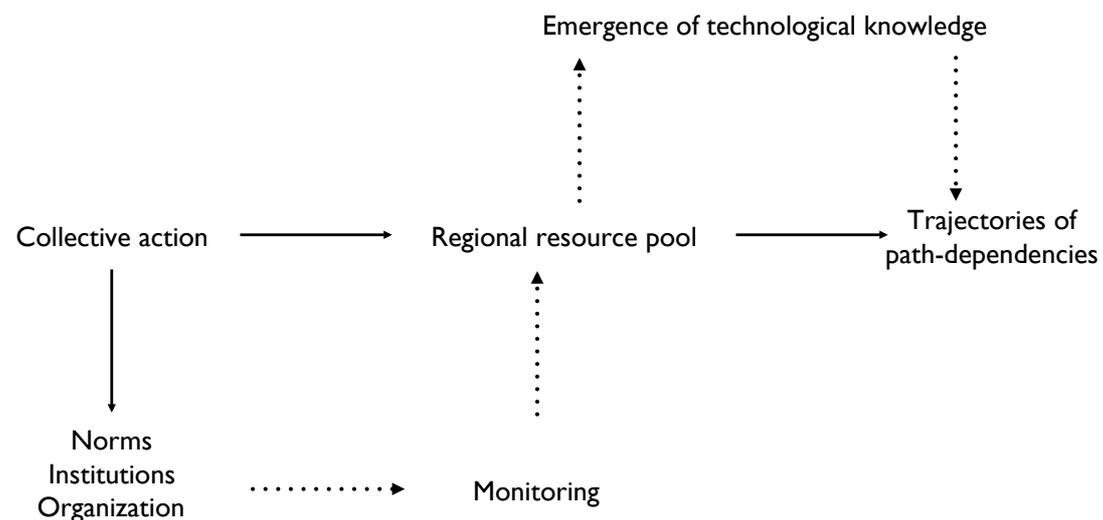
More broadly, the concept of the tragedy of the commons has been used to refer to knowledge development, most famously what is called the tragedy of the anti-commons in biotechnology (Heller 1998; Heller and Eisenberg 1998). The basic notion is that within scientific research around biotechnology, too many patents and intellectual property rights will lead later to fewer and fewer useful products. The reason is that too many owners of intellectual patent rights can block future users. Heller and Eisenberg (1998) argued that there are particular reasons for expecting the tragedy of the anti-commons in biotechnology in relation to patents. Later work explored this proposition empirically. Walsh, Arora and Cohen (2003) found that even though patents had increased, especially for research tools, that this had not impeded drug discovery. This debate of course only focuses on one, albeit highly important element of governance, namely intellectual property rights.

From a theoretical perspective, we have established that knowledge is a particular type of public good, which can be developed into a common resource pool. An innovation system has the properties of a polycentric, emerging, complex system. The special characteristics of the type analyzed in this paper is that firm behavior as well as the overall direction of such a system relies upon the engagement of multiple actors in developing technological knowledge at the regional level, in an historical, path-dependent process of evolution. This process involves variety creation, the building of resources and capabilities, and selection over time, in a process involving multiple organizations and distributed innovation systems involved in governance.

3.2 Conceptual Model

This section presents our conceptual model, in order to define the attributes (mechanisms) in the process enabling governance of regional innovation systems. The model should help explain the specific relationships between variables in this dynamic process.

Figure 1: Conceptual model of governance of a regional innovation system



“Collective action” is the first attribute in understanding this particular type of governance, which we are assuming was initiated by public policy. By that, we mean that a public policy initiative – such as a university-industry center – stimulated diverse actors to work together. After public policy stimulated this embryo of collaboration, organizations with different incentives and networks had to collaborate. Collective action is thereafter a self-organizing process, whereby different public and

private actors are engaged, in different ways, to invest and develop relevant scientific, technological and business knowledge relevant for innovation. The research projects may be financed by public or private or by both public and private sources. Given previous research on innovation systems, typical actors would be universities, industry and regional government.

“Regional resource pool” results from this collective action. This attribute should be analyzed in how a common pool of knowledge around a technology and industry are developed. One aspect is development and one is diffusion, albeit absorptive capacities indicate that a firm must have capabilities in a technology in order to monitor and absorb knowledge through collaborations with others. Likely, multiple organizations are involved, and diffusion occurs through public-private interactions through networks of relationships, collaborations and partnerships to stimulate technology at the regional level. There are also aspects of how collective action helps create a shared understanding of a technology and its commercial applications as products and services.

“Norms, institutions and organizations” are moderating influences on whether and how the collective action does, or does not, lead to the creation and maintenance of a regional resource pool. The focus upon norms and institutions refers to the Ostrom proposition about the establishment of self-regulating norms and institutions, which help keep actors committed to collective action as well as help regulate the benefits to participants and the sanctions to free-riders. Moreover, organizations represent formal organizations, which may be considered more tangible constructs. The previous section addresses the need for governance, given the diversity of incentives and networks of the participating organizations. Finally, since our focus is upon regional innovation systems, the networks across these organizations – whether globally or

locally focused – should help create a conduit for regional resources and endowments to be used collectively amongst the organizations.

“Monitoring’ leads from norms, institutions and organizations into the regional resource pool because monitoring is very important within studies of governance. Monitoring expresses the need for organizations involved to find ways of ensuring that the collective action benefits the diverse actors who are individually and collectively committed to developing the regional resource pool. There may also be problems with monitoring of free-riders and spill-overs, as well as inappropriate behavior. This discussion thus links back to classical views of governance in political science, as discussed in relation to our case in the previous sub-section. Therefore monitoring through collective action related to norms, institutions and organizations becomes very important, in order to channel knowledge and other resources and to keep individual organizations committed to collective action.

“Emergence of technological knowledge” results from the regional resource pool because specialized results are developed and diffused. The actors participating in regional innovation governance will thus create, maintain, and further improve a knowledge pool around certain technological fields. Previous research suggests that regional innovation systems are specialized into particular technologies and industries. The specialization will also change over time.

“Trajectories of path-dependencies” can be seen as an outcome of the regional resource pool, as mediated through the emergence of technological knowledge. Our idea is that these collective action and development of a regional resource pool will influence the path dependency of a region, in terms of specializing in particular types of technology. In other words, the combination of a regional resource pool and specialization in technology/industry provides actors located in the region with better

information about the new technologies per se or about the new uses, such as different applications and markets. A regional capacity to innovate is developed amongst, and between, organizations in the innovation system, and this also affects the capabilities of specific firms.

In summary, governance of this type of system can lead to positive outcomes – beneficial to most if not all participants – when the self-regulation works. Or, it may lead to social dilemmas and tragedy of the commons, when certain actors exploit the benefits from a regional resource pool. The conceptual model recognizes that different types of organizations involved in the production and use of knowledge, where each has a different set of incentives and networks. However, the governance requires the development of common norms and institutions for the collective action. In other words, the collective action is mediated by interacting, where they can develop common norms and institutions that regulate their behavior and help create a common good. The common goods here refers to technological knowledge in particular areas, which builds regional capacity and are useful for business innovation.

4. A RESEARCH AGENDA

Our aim in this paper is to use and further develop a diverse literature on governance, in order to enrich an understanding of a significant management issue, namely collaborations around technological development. In doing so, this paper develops a conceptual model of governance of regional innovation system. The specific type are ones is initiated by public policy, and the polycentric systems include firms, universities and government in the development of specialized technologies at the regional level. Special characteristics of innovation processes, and their effects upon

the propensity of firms to engage in collaboration for innovation have also been discussed. The analysis and conceptual model define the mechanisms enabling governance of the regional innovation system as well as to analyze how public policy and firms engage.

For later research, the aim is that this conceptual model should be useful:

- To further describe how this framework works theoretically, for the establishment and maintenance of the innovation governance, based upon mutually reinforcing social structures, norms and behavioral patterns
- To specify a framework that contains concepts and indicators for independent variables and dependent variables that can be tested empirically, preferably through quantitative approaches
- To propose a series of differing outcomes and processes that can be explored empirically, preferably through case studies

One set of topics on a future research agenda has to do with the implications for understanding the firms active in such regional innovation systems. A key question for a manager is whether, and when, the positive or negative outcomes discussed below will benefit their firm, and especially whether and when governance helped to increase the probability of successful innovations in the market. The conceptual model suggests that channeled knowledge and resources at the regional level is made available to the participating actors, stimulating further collective action. However, we know that at points firms will not benefit, and there are interesting questions about the limits, and trade-off of collective action as opposed to individual firm autonomy. Related questions to explore are whether, and how the initial technological capabilities and resources of norms and identity, e.g. endowments at time of venture

creation, are vital to the survival, growth, and life-chances of specific businesses engaged in a regional innovation system.

For firms, another issue is the spatial scale of analysis. The analysis in this paper has focused upon regional innovation systems, and yet especially for firms, their networks are also global. Therefore, it is necessary in future research to explore the impact and importance of global relations for a specialized area of technology. Several studies have discussed the effect of exploiting local-global informal knowledge linkages on regions in the creation and growth of firms (Gereffi and Korzeniewicz 1994; Lall 1996; Ernst 2002; Schmitz 2004; Chen 2009). The interesting issue is that global relationships can bring in information about developing technologies and markets, on a global scale, and bring it back into the regional / local level. However, we suggest that global relationships are more sporadic and more occasional than regional networks, and therefore have different modes of governance.

Global relations may, however, be important for other reasons. Global relationships could bring in information about global opportunities in market and technology, thereby avoiding lock-in to local optima. However, we know little about the relative willingness of firms to share such information to others in a regional innovation system nor how the local-global linkages impact governance.

Secondly, in terms of future research relating firms to public policy, the issue of capacities in and amongst firms seems the most promising avenue. In order to understand that regional capacity building can lead to a social dilemma, we propose that more work should be done on conceptualizing, and testing, how governance works in practice, within different types of complex, emerging innovation systems. In particular, we know little about the limits of public policy initiatives, as well as how to measure outcomes, when the effects are intended to be systemic and address norms

and institutions. Key questions to explore here are how regional (local) governments can design frameworks to stimulate an emerging, self-organizing process of governance? What institutions and framework conditions are necessary in order to stimulate actors to join, and to later develop self-regulation? Should the government be involved and interested in limiting the access to the resource pool and prevent free-riding? Or should the government stimulate the widest possible diffusion?

A final set of future research topics involves whether and how our conceptual model can help us make more exact predictions, and thereby help validate the conceptual model.

We have proposed that this conceptual model can be used in detail, and be analyzed in terms of path-dependencies and the impact on future outcomes. By success, we mean that there is a higher likelihood of innovating, for participating firms. The other organizations – universities and government – may also achieve their incentives and networks, but here, we are primarily interested if the regional innovation governance leads to innovations, which include novelty but also market success. By directionality, we mean that how the attributes in the model play out in practice will influence the type and direction of technological developments.

Path-dependencies suggest that spatial and historical factors influence the future. We suggest that success in terms of innovativeness as well as the directionality of technological specialization is an empirical question, more than a theoretical question. Theoretically, we can predict better or worse functioning systems, and that the attributes in the model can be used. Empirical studies are needed, however, to validate the conceptual model, and help make sharper predictions. Because an emerging complex system perspective is accepted as the context for firm action, therefore, the success and directionality of specialization will be dependent upon the governance of

a specific region studied empirically. An empirical study can be set up, to analyze quantitative as well as through one or more cases meeting our specific characteristics. The purpose would be to demonstrate whether different processes specified in our conceptual model do indeed lead to different results and whether the conceptual model provides tools to explain why results differ.

This expectation is based upon our understanding that the translation of knowledge into business innovation and entrepreneurship should be seen as a special case of a process of economic emergence. This process involves variety creation, the building of resources and capabilities, and selection over time, in a process involving multiple organizations and distributed innovation systems involved in governance.

The three sets of issues discussed above indicate a rich research agenda, can be studied in relation to the conceptual model proposed here, and which will further our understanding of the governance of regional innovation systems.

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