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Biotechnology as a Low-Level-of-Coherence Policy Priority: Effectual-Targeting and the Need for Learning and Experimentation Capabilities

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Abstract

In recent years policymakers in various positions have been adopting a systems-approach to policy thinking. However, in contrast with the quasi-evolutionary way in which policy is thought of and conceptualized it seems that policy doing is still being guided by ?market-failure? justifications causing actual policies to remain narrow in their scope. In this paper we sidestep this analytical divide of Thinking/Doing by developing a co-evolutionary framework that utilizes Sarasvathy?s (2001) more productive analytical divide of Means/Ends. That is to say we focus on a process of co-evolution (Avnimelech & Teubal 2008) of a higher-order, one which takes place ?inside? the agent of policy herself, and involves changes in the ways ?means? and ?ends? are understood and acted upon. Conceptualizing policy problems in terms of Means/Ends contributes to current debates by rendering the difficulty that countries are facing in their attempts to prioritize biotechnology more intelligible and thus manageable.

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Keywords: biotechnology; innovation strategy; technology & innovation studies; learning; emerging technologies

Introduction

Significant progress has been made in recent years in spelling out what Evolutionary Economics is about (see Witt 2003). While analytical headway has been gained in the literature (see among others Lambooy and Boschma 2001; Bottazzi et.al 2001, Malerba and Nelson 2011) it seems that the sphere of policy is lagging behind. Policymakers in different countries, including the OECD as an organization, have been adopting a systems-approach to policy thinking (Howelett and Ramesh 2003); however, in contrast with the quasi-evolutionary way in which policy is thought of and conceptualized it seems that policy doing is still being guided by 'market-failure' justifications causing actual policies to remain narrow in their scope (Dodgson et al. 2010). Such policy doing

implicitly assumes that the future is predictable, in the sense that policymakers can predict the ‘actual’ or ‘optimal’ outcome of a certain market and consequently intervene so to change a suboptimal steady-state to a more efficient one. In other words, policymakers posit themselves as able to define and articulate the ‘means’ and the ‘ends’ of policy action.

Currently, when challenged with the realization of a policy priority, the literature is implicitly assuming that the priority of policy is known to all stakeholders and understood in the same manner. Policymakers act as if they understand both the system that they are interacting with and how the priority in question can be brought into existence by such interaction (Edquist, 2011; Senker et al. 2012). That is to say, both what constitutes the ‘ends’ of the policy process and what is understood as the ‘means’ of achieving it are accepted in an unproblematic way; the divide between the two is not questioned and action proceeds without reflection. However, when a Low-Level-of-Coherence (LLC) between how stakeholders construe the priority exists (and there are different possible reasons for such a scenario), grounding a policy process on such premises becomes highly problematic and misleading (Kay, 2006).

Recently, a growing body of research centred on processes of co-evolution has offered an evolutionary-based conceptual framework which holds promise for both policy thinking as well as policy doing (Uyarra 2009; Rosiello et al. 2010). Nonetheless, in many cases, there is an analytical divide in the literature between policy thinking and policy doing where the 'doing' side of policy is conceived as sequential to the ‘thinking’ side. In this paper, we like to sidestep this analytical divide of Thinking/Doing by developing a co-evolutionary framework that utilizes Sarasvathy’s (2001) more productive analytical divide of Means/Ends. More specifically, we focus on a process of

co-evolution of a higher-order, one which takes place ‘inside’ the agent of policy herself, and involves changes in the ways ‘means’ and ‘ends’ are understood and acted upon. This emphasis allows us to highlight a certain type of policy priority (such as the prioritization of biotechnology) which current innovation policies find extremely hard to address successfully. The divide of Means/Ends renders the difficulty that countries are facing in their attempts to prioritize biotechnology more intelligible. Using a framework that builds upon the notion of Evolutionary Targeting (Avnimelech and Teubal 2008) and an Effectual Logic (Sarasvathy 2008) we offer a characterization of a policy process which has an LLC-type priority. Specifically, we deal with a priority which is not fully coherent both in terms of the 'ends' which it implies and the 'means' which these call for at the moment of selection and thus might lead to various understandings among different relevant stakeholders. That is to say, it has a Low-Level-of-Coherence. To use Colebath’s (see Kay 2006, 102) terminology, an LLC-type priority will lead to a divergent pattern of activity among the participants in the game; thus placing the very notion of ‘targeting’ in question As will be elaborated below, we posit that foresight in ‘biotechnology’ adhere to such difficulties.

What is important to note is that we are not simply referring to a cognitive shortcoming of the involved parties. It is not that stakeholders misunderstand or misconstrue the priority, e.g., biotechnology, and so a process of realignment between 'means' and 'ends' is in order (this has been thoroughly discussed by Argyris and Schon (1978) and addressed by their double-loop learning model). Here, we are trying to explicate a more radical lacuna that hinders on the process of policymaking. In the example of biotechnology, the very division been 'means' and 'ends' has not yet been established in reality (for an elaboration of this stand towards reality see Akrich et.al. 2002). Thus, this is not a problem of correspondence between 'means' and 'ends' which

can be done away with by a revision of the latter. What constitute a 'mean' and what constitute an 'end' is what at stake during the design and implementation of such policy schemes. Learning has to take place, by-doing, so as to cultivate processes that could be used to distinguish between what can qualify as a ‘mean’ and what as an ‘end’.

To make this point clearer, one should try and think about the following questions in regard to the prioritization of biotechnology: "Is strengthening basic science a mean or an end?", "Is reaching a critical mass of indigenous start-ups a mean or an end?" or "Is establishing a local presence of international companies a mean or an end?" The answers to these questions are not simply controversial –of course they are also that– it is that no single case study can be invoked as an example of a successful attempt at realizing the prioritization of biotechnology (see Cook in this issue). Lack of successful case studies hampers not only the ability to identify successful policy means but also the ability to determine the desired expectations from the prioritization process. Focusing on the difficulties such priorities pose for policymakers allows us to offer a characterization of a policy process which is evolutionary in both policy thinking and policy implementation.

The paper is structures as follows: the next section presents how scholars used co-evolution as a framework for thinking about policy in an evolutionary manner. This allows us to highlight how conceptualizing the innovation system as co-evolving over time brings to the fore the need for policy adaptability. Following, we propose a co-evolution process of a higher order between what is understood to be the end of policy intervention (what is prioritized, or targeted) and the actual implementation of means to achieve it. Exploring this process enables us to point next to the difficulty of pursuing policy targets which are not fully understood by current research, such as

'biotechnology'. The Logic of Effectuation, which explicitly addresses the Means/Ends divide, is than presented as a possible solution to such difficulties. To conclude, we discuss the need for knowledge management and experimentation mechanisms within the innovation system.

Co-Evolution as a Framework for Evolutionary Innovation Policy

Utilizing a system approach to policymaking, the literature on processes of co-evolution presents a dynamic policy perspective which focuses on reciprocal processes of between different dimensions within the innovation system. Co-evolution is here understood as processes in which change in one dimension may trigger changes in another, and vice versa (McKelvey and Holman 2006; Witt 2003). A significant contribution to the way we understand the role of policy in regards to such processes has been made by Avnimelech and Teubal (2008). Based on an analysis of the emergence of Venture Capital (VC) industries alongside High-Tech clusters, they had shown that these two elements (firms and financing agents) of the innovation system are better understood as co-evolving over time. Their perspective allowed them to view policymakers as able to cultivate structural development through intervention at crucial, mutual transition points by implementing a mixture of horizontal (policies that are not selective, e.g., the support of R&D in all sectors) and vertical (pertaining to a selected sector/technology/capability) set of policies. In such a way, policymakers act on the development path of the innovation system rather than simply providing incentives for various actors within the system in the hope of better performance.

Similar patterns of intervention which emphasize the importance of institutional change and the non-linear responsiveness of policy to market-led processes were also recognized in studies on policy oriented at the development of biotechnology clusters.

By analyzing policy initiatives in Sweden, Lundequist and Power (2002) had shown that successful policies aiming at the development of different types of industrial clusters all shared a common transition in perspective from a focus on the individual firm to a more systemic-holistic (Lundequist and Power 2002, 698). That is to say, policy thinking in these cases shifted to a more adaptive viewpoint, which understands the environment as vibrant and shifting, as oppose to viewing policy as the design of a static, immobile set of mechanisms. Their findings showed that this shift was not limited to policies aiming at the development of ICT clusters alone, but also biotechnology ones. Likewise, when comparing between the Swedish and Danish sides of the Medicon Valley biotechnology cluster, the extent to which policy has been reactive to the needs of the market, i.e. dynamically changing alongside changes in industry, was also recognized as having a crucial role in the support of the development of the biotechnology cluster (Braunerhjelm and Helgesson 2006). More recently, Rosiello and Orsenigo (2008), taking a more explicit approach, described regional innovation policy in terms of the co-evolution of the life sciences and the biotechnology industry; thus showing the applicability of a system-approach which is based on an evolutionary framework to the analysis of policy in these areas and its productiveness in formulating policy recommendations.

The works cited above stress, explicitly or implicitly, the co-evolution of different dimensions within the same, usually sectorial innovation system. It has been shown that co-evolution takes place among different groups of agents within the system. It appears between two groups of agents on the industrial side of the innovation system (e.g. the co-evolution of the VC industry and Start-Up companies within High-Tech clusters); it emerges between agents of academia and agents of industry as with the co-evolution of life sciences and the biotechnology industry (Cooke 2002) and it has also

been shown to exist between agents of policy and agents of industry (as with the co-evolution of supportive policy and the biotechnology clusters in Denmark and Sweden) (see Hofman et al. 2004 for a different typology).

This sort of co-evolutionary policymaking was suggested as an alternative to common policymaking which insists on focusing on the diagnosis and remedy of market-failures, i.e. subsidizing R&D investments due to spillover effects and sub-optimal market results which they bring, while neglecting aspects of system-failures which relate to the entire innovation system and are more responsive to policy interventions. From an evolutionary perspective, an implicit selection of policy priorities (e.g., nominating biotechnology as a prioritized technological competence within an innovation system) is both logically coherent as well as empirically shown to be optimal in particular settings. Policymakers are thus encouraged to assume the role of catalysts of processes of variation, selection and supporters of processes of retention (see among others Teubal and Zlotnik 2011; Dodgson et al. 2010; Metcalfe 1995; Breschi and Malerba 1997; Smith 2000). This line of reasoning provides policymakers with a framework with which both to think about policy and to conceptualize ways of doing policy. By conceptualizing the innovation system as undergoing phases of evolutionary development, policymakers are cognizant of the time dimension of policy and are thought as able to contribute to the advancement of phases (background, pre-emergence, emergence) (Avnimelech & Teubal 2008). That is to say policymakers target desired positions on the co-evolutionary developmental cycle.

This reliance on a system-based framework still presumes that policymakers are familiar with the system they interact with and, even more so, that phases are clearly recognizable. This, as we will address below, brings great conundrums for

policymakers. We will now turn to suggest an additional possibility of co-evolution, one which takes place within the sphere of policy itself and which brings to the fore the problems facing policymakers. The latter mean that policymakers will also have to be cognizant about their own evolutionary development in regards to the understanding of the actual priority being targeted.

Co-Evolution of a Higher-Order: A Fuzzy Divide of Means/Ends

The framework of co-evolution has contributed to the formulation and conceptualization of innovation policy which derives explicitly from a system-evolutionary perspective (Lundequist and Power 2002). The discussion can be taken forward by suggesting an additional possibility of co-evolution within the innovation system; one which will enable us to better understand the complexity of the process of priority settings when dealing with a certain kind of priorities.

Instead of dealing with co-evolution between different groups of agents, we centre on the way the process of policy is conceptualized among and between groups of policy agents. Both those who formulate (policy thinking) and those who implement policy (policy doing).[1] This is a narrower scope, but a deeper one which elucidates the co-evolution which takes place among these agents and/or 'inside' the same agent herself in the sense that the concepts and the divide between what constitute an 'end' and what a 'mean' emerges gradually and only after implementation has unfolded in practice. To put differently, we posit that policymakers' understandings of the target of

[1] These might include any configuration of interaction between policymakers involved in policy articulation, in the local or governmental levels (for various configurations see Wong 1998; Rochepeau 2004; Trajtenberg 2002).

an evolutionary targeting process also evolves.

Literature on the subject of conceptual change in policymaking has mainly focused on the evolution of policy agendas (John 2003; Flanagan et.al. 2011; Kay 2006) and its relation to the process of policy implementation (e.g. Slembeck 1997). As mentioned, the need for a 'double-loop' learning process (Argyris and Schon 1978), where goals are re-evaluated and theories of action are substituted once actions have discovered an error, has been established in the literature. However, thinking within an evolutionary perspective, in this paper we explore situations where this cannot take place.

Ours could be understood as a particular problem of the emergence of a frame. Studying the way meaning in interactions is organized, Goffman (1974) proposed that all interactions in society are framed. That is, there is a frame which transforms what would otherwise be meaningless in a scene to something meaningful for the participants; be it parties in a conversation, actors on stage and their audience –and by extension also policymakers and their contributing stakeholders. Goffman used the notion of "information states" to indicate "the knowledge an individual has of why events have happened as they have, what the current forces are, what the properties and intents of relevant persons are, and what the outcome is likely to be" (Goffman 1974, 134). Our point is that there are scenarios where the information states of stakeholders are divergent and misaligned as there is no shared perspective, no single horizon to which to direct everyone's gaze. For Goffman, frames are responsible for the stabilization of distinctions. In these scenarios, the framing of the policy process in terms of the distinction between Means/Ends is lacking, and no clear distinction can be made that will remain stable during policy implementation. This fuzziness of the

Means/Ends divide is due to the fact that when dealing with emergent technologies the understanding of the business and financial structures of sectors or the importance of academic research for their development are frequently altered and what policymakers construe as relevant expertise, capabilities, activities or entities are far from stable, as will be elaborated below (see also McKelvey and Holmen 2006, 25).

A divergence in information states will affect the process of policymaking. For instance, the concept 'innovation' was shown to be highly ambiguous. Stakeholders from industry, academia and the sphere of policy have very different perspectives when it comes to defining innovation and classifying it (Slembeck 1997). These sharp variations –which can be understood as a result of an unsuccessful framing and the proliferation of competing information states– led to a situation where official data gathered by government officials on innovation in Italian Small and Medium Enterprises (SMEs) showed that these businesses are non-innovative, while a research that used direct surveys yielded a different picture, one which placed the Italian SMEs as radical innovators (Massa and Testa 2008). That is policymakers with different information states could not maintain a singular framing of 'innovation'. In the same vein, such misaligned perspectives might prevail in regards to the prioritized target of an evolutionary targeting process, such as 'biotechnology'. We move now to discuss such priorities and explore the fuzziness of the Means/Ends divide.

Policy Targets with a Low Level of Coherence

As mentioned above, multifarious ways of construing the target has consequences; thus we take as our premise that the implementation process is shaped by the Level of Coherence of the policy priority that is targeted. In order to make this clearer, we will begin by outlining an extreme case where the Level of Coherence of the target is very

high. That is, there are instances where innovation policy is not facing the problem of a Low Level of Coherence. That is to say policymakers and other stakeholders are able to conceptualize it in a similar manner; there is a common information state that they can all share. This case is illustrated by the top-right area in Figure 1. When evolutionary targeting is dealing with the support and/or establishment of e.g., Wine, Furniture or even the Internet Software industries, the level of coherence of the objective is relatively high. This is due to the fact that the development paths of such clusters are known and a number of best practices could be followed. Such industries have relatively robust business models which are agreed upon thus making the issue of understanding what the target means in particular rather straightforward (Hospers 2005).

[FIGURE 1 APPROXIMATLEY HERE]

On the contrary, with targets that have a low level of coherence it is likely that agents involved in the process do not necessarily share the same conception of the objective and consequently neither the conception of the needed policy measures that are needed. These are illustrated in the bottom-left area in Figure 1. In the cases of Biotechnology, Cleantech or Nanotechnology, e.g., there is no consensus (neither in the literature nor among interested parties) regarding the particularity of what these terms refer to in practice (Grabner et.al, 2001; Wonglimpiyarat 2005). Consequently, stakeholders who are involved in policy thinking (e.g, government officials, advisory board members, industry advocates and other stakeholders that contribute to policy formulation) and in policy doing (e.g, government officials responsible with the implementation of policy decided upon) have varying notions of what the priority denotes in particular in terms of possible ‘means’ to reasonable ‘ends’ and how best to

approach it. The border between the two is fuzzy and incoherent. As each stakeholder construes the objectives differently, the designation of a single priority might become almost self-defeating (see Hay in Flanagan et.al 2011, 321; Cooke 2002).

While not all innovation policy deals with LLC-Type priorities (see the principal discussion above on cases with a high level of coherence), Biotechnology is an exemplary case of an LLC-Type Priority. The terms 'biotechnology' is often used to denote the target of grand policy intervention programs. However, there is yet to emerge a paradigmatic model which details what sorts of specific technologies, skills, infrastructures or capabilities this term refers to. When policymakers invoke 'biotechnology', they might be referring, e.g, to Therapeutics, Medical Devices, Agribiotech, Bio-services, Bioinformatics or Bio-Environment, among other possibilities (for an overview of selected approaches, see McKelvey et al. 2004). Moreover, as no single development path has been identified as robust enough for policymakers to use as their ideal for recreation, disagreement might prevail among stakeholders regarding the needed type of interventions (e.g. finance, basic science, industrial R&D, etc.). It is in this regard that 'biotechnology' as a target of policy might not be fully coherent; not in virtue of its boundaries or constituents and not in virtue of the way these dynamically develop (Cooke 2002). No stable frame distinguishing clearly between 'means' and 'ends' has emerged and crystallized so it is likely that stakeholders will have conflicting information states (Nederhof 1986).

As mentioned above, we here understand co-evolution as processes in which change in one dimension may trigger change in another, and vice versa. The first dimension we presented was the level of coherence of the priority, or the multifarious information states shared among stakeholders. The second dimension was the one of

policy implementation, or actual schemes and intervention mechanisms put into practice in the hope of reaching a certain target. Thus far we have discussed one direction of influence, highlighting why the level of coherence of the priority might impinge on implementation attempts. We will now turn to establish the second direction of influence, namely from implementation to the level of coherence of the priority.

We contend that for policymakers to address LLC-type priorities successfully it is not enough to revise 'goals'. A more radical approach is needed, one that enables implementation to affect policy thinking and more so that allows for the Means/Ends frame to emerge and stabilize. To explore this space of possibilities we will now present the Logic of Effectuation.

The Logic of Effectuation: A Framework for Addressing LLC-Type Policy Priorities

We have discussed how multiple information states might influence policy implementation and why this should be expected when dealing with LLC-type priorities. In such cases, it is highly problematic to formulate a concrete plan for action for a target to be achieved. We build on the logic of Effectuation, which assumes that selecting the proper means and allocating probabilities for their success is impossible or even unintelligible (Sarasvathy 2001; 2008), as a possible solution to the challenge at hand. We content that the logic of Effectuation is consistent with the evolutionary concept of emergence due to its emphasis on exploration and learning capabilities and that by adopting it, the second direction of influence can be established, namely allowing implementation to influence the level of coherence of the priority. We begin by outlining the difference between the Logic of Causation and the Logic of Effectuation and then discuss how Effectuation can contribute to an evolutionary-based

policy which targets priorities that are characterized by LLC.

The Logic of Causation

Investigating the ways in which expert entrepreneurs conceptualize problems and actions Sarasvathy (2001) recognized that these individuals were driven by a specific logic she terms a Logic of Effectuation. Sarasvathy contrasted the processes of Effectuation with the processes of Causation. Causation processes are those usually employed when a goal is to be achieved. These processes are outcome-oriented, where a future goal is addressed as given and the focus is on choosing efficient ways of reaching it. As such, the Logic of Causation assumes that the various trajectories of reaching the goal are relatively known and that the problem is to answer the question: "which mean has the best probability of success"? To illustrate how so, Sarasvathy suggested a simple example of a chef assigned with preparing dinner. Following a process of Causation, the chef decides on the exact dish to be prepared (the future desired goal he regards as given) and then goes about to get the needed ingredients (the most efficient way of causing the goal). The chef here assumes that he can predict what will be the most efficient means to cause his pre-selected dish to materialize. There is no ambiguity between the means and the ends (Sarasvathy 2008, 74).

With regards to policy, Causation is most relevant to cases where the target has a high level of coherence, as with those illustrated at the top-right area of Figure 1. That is because in such cases a distinction between what can be regarded as an 'end' and what are possible 'means' has already established in practice. With the Internet Software Industry, e.g., the working assumption is that a policymaker can predict which means are necessary in order to build a successful software cluster and that it is possible to pick-up the most efficient policy tools from a known "toolbox" (as in the cases of, e.g,

the Bangalore software cluster (Basant 2006) and the Irish ICT cluster (Green 2000)). Commonly, she will base her plan on a study which, after analysing different factors such as: local competitive advantages, stage of the industry, institutions and regulations, education level, etc., will enable her to propose the means, the timeframe and even to set the price for this intervention. At the end of the process she might even be able to discuss the potential Return on Investment of the plan as matrices for evaluation are often available. Thus, the challenge is understood as one of selecting between or integrating well-known elements by creating a proper policy mix.

However, this is not the case when dealing with emergent technologies (Bresnahan and Gambardella 2004). For such scenarios Causation processes will not do. First, with Biotechnology, i.e., when the development path of the technology, science and supportive institutional setup is not established completely, using a process which assumes a predictable future is questionable. Moreover, the environment which policymakers are operating within is turbulent and pervaded with radical uncertainty (Dew et al. 2011). This means that probabilities of future success are not simply unknown but also unpredictable making the future simply unknowable. As a result, the means and elements which are required to achieve this unpredictable future can rarely be defined as well. Second, as stressed above, when dealing with LLC-Type priorities, policymakers may not share the same understanding of the priority and thus the goal itself cannot be assumed to be given. Taking into account the variance in information states between different stakeholders, there is in fact no single specified goal. In other words, under LLC conditions Causation processes are contradictory by definition as the logic of Causation is implicitly teleological. Here, the logic of Effectuation becomes relevant.

The Logic of Effectuation

As oppose to Causation processes, which focus on predicting the success of different means in causing a known certain goal, Sarasvathy posits the Logic of Effectuation. As she observed the behaviour of expert entrepreneurs operating in a market environment characterized by high degree of uncertainty, she realized that these expert entrepreneurs acted as if the future cannot be predicted. Their actions reflected a logic which assumes that selecting the proper means and allocating probabilities for their success is impossible or even unintelligible (Sarasvathy 2001). Accordingly, they did not set a specific future goal in advance but rather tried to understand what goals can be achieved within a general ambition. This highlights an important difference between the two logics. While Causation focuses on predicting the future, in terms of pre-selecting the future goal and assuming known probabilities for successes for various actions, Effectuation focuses on creating a yet-to-be-known future by a process of experimentation. Instead of focusing on detailed planning of the future and the means required to achieve it, the logic of Effectuation is focused on setting up learning mechanisms, or an environment of cultivation aimed at the emergence of possible futures (consisting of varied configurations of Means/Ends). This consists in taking actions that make it easier to distinguish between ‘ends’ and ‘means’ and thus assist in creating a common understanding among stakeholders.

Going back to the sphere of policy, it is here where one can see the evolutionary coherence of this logic (Sarasvathy and Dew 2005). Unlike Causation which links policy implementation with specific and well defined goals, policy processes that are based on Effectuation should perceive policy implementation as an opportunity to better understand the target. The policymaker is not trying to cause a specific goal, because

she realizes that ‘ends’ are not fully distinguished at the moment of initial policy design. Rather, she aims to initiate a process that will lead to different possible effects, out of which ‘means’ and ‘ends’ could later be delimitated. Once variation has taken place, policymakers can than select the desired effect among different possible effects that are starting to emerge (Uyarra 2009; Flanagan et.al. 2011). In essence, the logic of Effectuation does not call for priority setting but rather for prioritization process where the exact content of the subject being prioritized is being crystalized over time. The exact priority, so to speak, ‘emerges’ with this process as a clear distinction between means and ends stabilizes. It is articulated only when knowledge on the sector’s dynamics and its development path has accumulated and once different stakeholders begin to understand the domain being targeted in the same way and are sharing similar viewpoints on the proper ways to promote it.

Consequently, effectuation is both suggestive of and coherent with an evolutionary approach to policy, shifting the emphasis of policy from outcomes to processes (Nill and Kemp 2009; Witt 2003). Adopting an Effectuation approach establishes the second direction of the co-evolution process we are describing. As mentioned above, the level of coherence influences policy implementation. A policy process guided by Effectuation is one where implementation is understood as a process of experimentation aimed at the emergence of clear distinctions between ‘means’ and ‘ends’; thus it is one where a bi-directional influence operates. Based on insights from how expert entrepreneurs operate within an unpredictable environment, Effectuation tells us that policy dealing with LLC-type Priority should allow for a co-evolution between policy thinking and policy doing, exactly because LLC-type priorities are not stable enough in terms of the ‘means’-‘ends’ divide.

This is the sorts of dynamics that we suggest should exist in cases where the priority is of an LLC-type. A co-evolution process between policy intervention and the framing of the priority itself, or more specifically the way these are conceptualized and understood by relevant agents, should take place. While preliminary and not fully specified, this framework can be very productive for discussing policy programs aimed at LLC-type priorities, such as biotechnology (see Kaufmann, this volume). Our main emphasis is that once recognized as potent, Effectuation provides a justification for knowledge management and experimentation mechanisms within the innovation system. That is to say for an innovation system where learning is not exogenous to implementation with a simple aim of evaluating its results, but rather endogenous. Since the logic of effectuation starts from analysing the existing means, rather than defining the expected results we believe that countries who adopt this logic have better chances of dealing with emergent technologies. This, however, is highly dependent on the ability of a country/region to develop learning mechanisms that are and on the ability of the policy system to engage in intervention or the sake of experimentation, meaning to act without clear criteria for success and failure.

Summary

Following Porter's 'competitive advantage of nations' (1990) many countries entered a structured process of mapping their clusters, evaluate the potential for their development and proposing a detailed plan for their development (for a comprehensive survey see: Boekholt and Thuriaux 1999). Many European programs as well as consulting companies provided different recipes on how to advance a specific cluster within a region (Bresnahan and Gambardella 2004; Hospers 2005). The OECD (2001) has even published a guide on boosting innovation through the cluster approach

providing detailed tools for policy makers. The these guides were based on the notion that the development paths of the different clusters, be it high-tech or traditional sectors, are well defined and that the elements which are responsible for their development have been, at least in principle, successfully mapped and addressed by academics and practitioners. It was assumed that we know what 'means' are required for achieving what 'ends'. However, the very limited success of these cluster policies, especially when it comes to the development of some high tech clusters (Cooke 2012; Hospers 2005) necessitates rethinking this policy approach.

In this paper, by focusing on a process of co-evolution of a higher order it was possible to elucidate issues that hinder on the articulation of a policy and open a space for discussing possible solutions (Teubal and Zlotnic 2011). We have presented an analytical framework which is based on a System-Evolutionary perspective and adopts the Logic of Effectuation. While not fully specified, this enabled us to propose a certain characterization of a process that could better handle prioritization of complex and especially emerge sectors with yet unclear specification and unknown development path. This consists of acknowledging the abstract nature of the priority and the creation of mechanisms of knowledge management, those which allow actions to influence concepts. This helped us sketch a trajectory that can help diminish the gap between policy thinking, which is changing and becoming more evolutionary, and policy doing, which remains linear. By adopting Effectuation policy doing moves closer to an evolutionary approach. While an evolutionary perspective has been able to establish the need for policy phasing and adaptively (Avnimelech et al. 2010), we stress that agents of policy should not remain dynamic only in terms of their selected means (changing schemes as problems arise), nor simply in their goals (re-evaluating the target once schemes fail), but also in terms of the way they conceptualize and understand which is

which.

Aghion, P., P. David, and D. Foray. 2009. Science, technology and innovation for economic growth: Linking policy research and practice in "STIG Systems." Research Policy, 38, no. 4: 681-693.

Akrich, M., M. Callon, and B. Latour. 2002. The Key to Success in Innovation, Part 1: The Art of Interesement. International Journal of Innovation Management, Vol. 6, no. 2: 187–206

Avnimelech, G. and M. Teubal. 2008. Evolutionary targeting. Journal of Evolutionary Economics, 18, no.2:151-166.

Avnimelech, G., A. Rosiello, and M. Teubal. 2010. Evolutionary interpretation of venture capital policy in Israel, Germany, UK and Scotland. Science and Public Policy, 37, no.2: 101-112.

Argyris, C., and D. Schon. 1978. Organizational Learning: A Theory of Action Approach, Reading MA: Addison Wesley.

Basant, R. 2006: Bangalore Cluster: Evolution, Growth and Challenges. Ahmedabad: Indian Institute of Management.

Boekholt P., and B. Thuriaux . 1999. Public policies to facilitate clusters: background, rationale and policy practices in international perspective.
In OECD (ed.) Boosting Innovation: The Cluster Approach, 381-412 . Paris: OECD .

Boschma, R. A., and J.G. Lambooy. 1999. Evolutionary economics and economic geography. Journal of Evolutionary Economics, 9, no.4: 411-429.

Bottazzi, G., G. Dosi, M. Lippi, F. Pammoli, and M. Riccaboni. 2001. Innovation and corporate growth in the evolution of the drug industry. International Journal of Industrial Organization, 19, no.7: 1161-1187.

Breschi S., and F. Malerba. 1997. Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries. In Systems of innovation: technologies, institutions and organisations, ed Edquist C., 130-156. London: Pinter.

Bresnahan, T., and A. Gambardella. 2004. Building High-Tech Clusters Silicon Valley and Beyond. Cambridge, UK: Cambridge University Press.

Colebatch, H.K. 1998. Policy. Buckingham: Open University Press.

Cooke, P. 2002. Regional Innovation Systems: General Findings and Some New Evidence from Biotechnology Clusters. Journal of Technology Transfer, 27: 133–145.

Cooke, P., 2012. From Clusters to Platform Policies in Regional Development. European Planning Studies, June: pp.1-10.

Dew, N., S. Read, S. Sarasvathy, and R. Wiltbank. 2011. On the entrepreneurial genesis of new markets: Effectual transformations versus causal search and selection. Journal of Evolutionary Economics, 21: 231-253.

Dodgson, M., A. Hughes., J. Foster., and J. S. Metcalfe. 2010. Systems thinking, market failure and the development of innovation policy: the case of Australia, Research Policy, 40: 1145–1156

Edquist, C. 2011, Design of innovation policy through diagnostic analysis: identification of systemic problems (or failure). Industrial and Corporate Change, 20, no.6: 1725–1753.

Flanagan, K., E. Uyarra, and M. Laranja. 2011. Reconceptualising the "policy mix" for innovation. Research Policy, 40, no.5: 702-713.

Goffman, E. 1974, Frame Analysis. Boston: Northeastern University Press.

Grabner, P., J. Hamperl, N. Lindsey, and H. Torgersen. 2001. Biopolitical diversity: the challenge of multilevel, in policy-making, In Biotechnology, 1996-2000: the years of controversy, eds Gaskell, G. and W. N. Bauer, 15-34. London: NMSI Trading Ltd.

Green, R. 2000. OECD Cluster Focus Group Workshop Utrecht, May 8-9: Irish ICT cluster. OECD website. http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/2754426.pdf

Hay, C. 1999. Crisis and the structural transformation of the state: interrogating the process of change. British Journal of Politics and International Relations,1, no. 3: 317–344.

Hofman, P. S., B. E. Elzen, and F. W. Geels. 2004. Sociotechnical Scenarios as a New Policy Tool to Explore System Innovations: Co-Evolution of Technology and Society in the Netherlands Electricity Domain. Innovation: Management, Policy & Practice, 6: 344-360.

Hospers, G. J. 2005. "Best Practices" and the Dilemma of Regional Cluster Policy in Europe. Tijdschrift voor Economische en Sociale Geografie, 96, no.4: 452-457.

Howlett, M., and M. Ramesh. 2003. Studying Public Policy: Policy Cycles and Policy Subsystems, 2nd edition. Oxford: Oxford University Press.

John, P. 2003. Is There Life After Policy Streams , Advocacy Coalitions , and Punctuations : Using Evolutionary Theory to Explain Policy Change. Policy Studies, 31, no.4: 481-498.

Kay, A. 2006. The Dynamics of Public Policy: Theory And Evidence. New Horizons in Public Policy. Massachusetts: Edward Elgar Publishers.

Lambooy, J.G., and R. A. Boschma. 2001. Evolutionary economics and regional policy. The Annals of Regional Science, 35, no. 1: 113-131.

Lundequist, P., and D. Power. 2002. Putting Porter into Practice: Practices of Regional Cluster Building. European Planning Studies, 10, no.6: 37-41.

McKelvey, M., A. Rickne, and J. Laage-Hellman, eds. 2004. The Economic Dynamics of Modern Biotechnology. Massachusetts: Edward Elgar Publishers.

McKelvey, M. and M. Holmen. 2006. Flexibility and Stability in the Innovating Economy. Oxford: Oxford University Press.

Malerba, F. and R. Nelson. 2011. Learning and catching up in different sectoral systems: evidence from six industries. Industrial and Corporate Change, 20, no.6:1645–1675.

Massa, S. and S. Testa. 2008. Innovation and SMEs: Misaligned perspectives and goals among entrepreneurs, academics, and policy makers. Technovation, 28, no.7:393-407.

Metcalfe, J.S. 1995. Technology systems and technology policy in an evolutionary framework. Cambridge Journal of economics, 19, no.1:25-46.

Nill, J. and R. Kemp. 2009. Evolutionary approaches for sustainable innovation policies: from niche to paradigm. Research Policy, 38, no.4:668-680.

OECD. 2001. Boosting Innovation the Cluster Approach. Paris: OECD.

Porter, M. E. 1990. The Competitive Advantage of Nations. New York: Free Press.

Rip, A. and A. Nederhof. 1986. Between dirigism and laissez-faire: Effects of implementing the science policy priority for biotechnology in the Netherlands. Research Policy, 15, no.5:253–268.

Rochepeau, A. 2004. The Pharmaceutical Biotechnology Industry in France. OECD website.

http://www.oecd.org/science/innovationinsciencetechnologyandindustry/34960843.pdf

Rodrik, D. 2004. Industrial policy for the twenty-first century. UNIDO Working Paper, September. http://www.newschool.edu/uploadedFiles/TCDS/Democracy_and_Diversity_Institutes/Rodrick_IndustrialPolicyfor21Century.pdf

Rosiello, A., and L. Orsenigo. 2008. A critical assessment of regional innovation policy in Pharmaceutical biotechnology, European Planning Studies, 16, no.3: 337-357.

Rosiello, A. G. Avnimelech, and M. Teubal. 2010. Towards a systemic and evolutionary framework for venture capital policy. Journal of Evolutionary Economics, 21, no.1:167-189.

Sarasvathy, D.S. and N. Dew. 2005. New market creation through transformation. Journal of Evolutionary Economics, Vol 15: 533-565

Sarasvathy, D.S. 2008. Effectuation – Elements of Entrepreneurial Expertise. Massachusetts: Edward Elgar Publishers.

Sarasvathy, D.S. 2001. Causation and effectuation: towards a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of Management Review, 26, no.2:243–88.

Senker, J., C. Enzing, and T. Reiss. 2012. Biotechnology in Central and Eastern Europe: An Overview of Performance and Policy Systems, In Exploring Central and Eastern *Europe's Biotechnology* Landscape, Peter, T.R., and H. Farah, eds, Springer.

Slembeck, T. 1997. The Formation of Economic Policy : A Cognitive-Evolutionary Approach to Policy Making, Constitutional Political Economy, 8, no.3:225–254.

Smith, K. 2000. Innovation as a Systemic Phenomenon: Rethinking the Role of Policy, Enterprise and Innovation Management Studies, Vol 1, no. 1: 73-102.

Teubal, M., and O. Zlotnick. 2011. Strategic Innovation Policy (SIP): A Systems Evolutionary Perspective with Examples. Proceedings of the Georgia Institute of Technology.

Trajtenberg, M. 2002. Government Support for Commercial R & D : Lessons from the Israeli Experience, In Innovation Policy and the Economy, Vol 2, Adam B., J. J. Lerner and S. Stern, eds, 79-134. Massachusetts: MIT press.

Uyarra, E. 2009. What is evolutionary about “regional systems of innovation”? Implications for regional policy. Journal of Evolutionary Economics, 20, no.1:115-137.

Witt, U. 2003. Economic policy making in evolutionary perspective. Journal of Evolutionary Economics, 13, no. 2:77-94.

Wong, P. K. 1998. Development of industrial and technological capabilities in Singapore: The Role of The State. NUS-CMT working paper.

Figure 1. Level of Knowledge and/or Consensus among