



Sequential problem choice and the reward system in Open Science

Nicolas Carayol^{a,b,*}, Jean-Michel Dalle^c

^a ADIS, Faculté Jean Monnet, Université Paris Sud, 54 Bvd. Desgranges, F-92331 Sceaux, France

^b BETA, CNRS and Université Louis Pasteur, Av. de la Forêt Noire, F-67085 Strasbourg, France

^c Université Pierre-et-Marie-Curie (Paris 6) and IMRI-Dauphine, Place Jussieu, F-75005 Paris, France

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Abstract

In this paper we present an original model of sequential problem choice within scientific communities. Disciplinary knowledge is accumulated in the form of a growing tree-like web of research areas. Knowledge production is sequential since the problems addressed generate new problems that may in turn be handled. This model allows us to study how the reward system in science influences the scientific community in stochastically selecting problems at each period. Long term evolution and generic features of the emerging disciplines as well as relative efficiency of problem selection are analyzed.

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1. Introduction

Nelson (1959) and Arrow (1962) first highlighted that the specific characteristics of knowledge considered as a public good result in a default in knowledge creation incentives. Consequently private investment in knowledge creation is below its optimal level. This very well known result appeared as a theoretical justification for public support of research which may (non-exclusively) be undertaken by funding a specific social institution, namely academia. In that respect, modern

* Corresponding author. Tel.: +33 140911860; fax: +33 141138273.

E-mail address: carayol@cournot.u-strasbg.fr (N. Carayol).

countries obviously support a network of public laboratories and academic researchers. After having focused on the social returns of public research, ¹ economists have logically begun to address the issue of the internal organization of the academic institution.

Dasgupta and David (1994) have recently synthesized in an economic fashion the mertonian mechanisms at play within academia. According to Merton (1957), the functioning of the academic institution, he labels *Open Science*, relies on social norms ² that generate a set of effective rules which stress a specific *reward system* in which *priority* is essential. The incentive mechanism at play may be sketched as follows. Peers collectively establish the validity and novelty of knowledge produced (peer review). The attribution of rewards is based on recognition by peers of the “moral property” on the piece of knowledge produced which increases the producer’s reputation within the community (“credit”). Dasgupta and David (1994) highlighted that Open Science functioning has two fundamental and original economic properties that contribute to its efficiency. First of all, it avoids some of the asymmetric-informational problems that might otherwise arise between funding agencies and scientists in public procurement of advanced knowledge: scientists themselves are certainly the most able to carry out verification and evaluation operations in the peer-review like procedures. Secondly, since it is precisely the very action of disclosing knowledge which induces the reward (reputation or credit increase), the reward system thus creates simultaneous incentives both for knowledge creation and for its early disclosure and broad dissemination within the community. That is why this mode of knowledge production has been said to have very interesting efficiency properties (Arrow, 1987) and even to constitute a “first best solution” for the appropriability problem (Dasgupta and David, 1994) as it solves the dilemma between knowledge creation incentives and knowledge disclosure incentives (Stephan, 1996).³

Several modelling exercises have considered specific dimensions of the academic institution. Carmichael (1988) attempts to explain why does the tenure system exist: it is the only reliable employment contract that guaranties scholars will provide correct advises for employing high quality colleagues who might otherwise challenge their own positions. Lazear (1996) models the effects of several funding rules (e.g. weight more past efforts or the quality of the proposal, engage few big or many small awards, favor junior or senior researchers) on the incentives provided to scholars. Windrum and Birchenhall (1998) study the impact of the credibility based funding pattern on the evolution of a population of research units. Brock and Durlauf (1999) introduce a model of discrete choice between scientific theories when agents have an incentive to conform to the opinion of the community. Levin and Stephan (1991) propose a human capital model of knowledge production which fits the usual inverse-U shape of life-cycle scientific productivity. Carayol (2005) proposes a model of scientific competition in which overlapping generations of researchers compete at the different stages of their career while universities also simultaneously compete to hire the best scientists.

In this paper we focus on another dimension of academic organization, namely the sequential determination of research agendas within scientific communities and the subsequent disciplinary knowledge production. Our point of departure is that even though competition between scientists is clearly important (associated with “winner-takes-all” rules and “waiting and racing games”

¹ For a recent and complete survey see Salter and Martin (2001).

² Literally, Merton (1942) labelled such norms “institutional imperatives”. Those norms are: “universalism, communism, disinterestedness, and organized skepticism”.

³ Of course, many problems still arise and it is not possible to derive from this statement that the decentralized allocation of research efforts induced by the specific reward system of science is *per se* optimal. This observation leaves room for an *Imperfect Economics of Science* to come (for a first investigation see Carayol, 2001).

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