An Evolutionary Perspective on the Costs and Benefits of Innovation

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Abstract

Innovation plays an important role in a variety of systems, from the evolution of animal species to the emergence of technology in the human society. In general terms, innovation is something new, and able to improve the benefits for a system, allowing the latter to evolve. In few words, innovation is an essential element that guaranties both the progress and breakthroughs. However, innovation has a cost, or is risky, so often individuals (and whole societies) can be afraid of it.
Freeman Dyson few years ago wrote a very interesting paper entitled 'Birds and Frogs', with a direct reference to the community of mathematicians. In his view, birds are those that fly with their mind up to see the connections between different fields of knowledge, thus they can be considered as innovators. At the same time, frogs are those able to deeply analyze mathematical problems, and their role is essential to put into practice innovations. We deem that this metaphor, i.e. birds and frogs, be really suitable also beyond mathematics. Notably, while innovators are able to propose new and great solutions, conservators have the ability to transform innovations into something that can be really used in our society. For instance, if an innovative scientist proposes a new model but none of her/his collegues go trough it investigating all the details, the innovator does not receive 'citations' (or recognitions) and, in her/his community, none takes profit from the new results.

In general, a careful mixing of innovators and conservators is mandatory for succeeding, i.e. to produce new usable ideas in science, technology, and so on. In addition, while innovators can also propose nothing new for a long time, usually conservators are more likely to produce improvements on consolidated ideas. Thus, at least in terms of productivity, innovators represent even a risk for a society.

Starting from these observations, we introduce a simple evolutionary game for studying the dynamics of a population composed of agents that can play as innovators or as conservators. Agents change their behavior according to the payoff, i.e. the gain, obtained by the group they belong to (equally divided among all components). In particular, the payoff depends on the mixing of innovators and conservators in each group, and on a numerical parameter called 'award factor', whose role is representing the policies of a society towards research and industrial production.

One of the main results of numerical simulations indicates the existence of a critical threshold

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of the 'award factor'. In particular, values lower than the critical threshold lead the agent population towards an ordered equilibrium (i.e. only conservators survive).
To conclude, we introduce an approach based on the framework of evolutionary game theory for studying a topic of increasing interest in different communities and sectors of our society.