

ON ALGEBRAIC GRAPH THEORY AND THE DYNAMICS OF INNOVATION NETWORKS

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ABSTRACT. We investigate some of the properties and extensions of a dynamic innovation network model recently introduced in [37]. In the model, the set of efficient graphs ranges, depending on the cost for maintaining a link, from the complete graph to the (quasi-) star, varying within a well defined class of graphs. However, the interplay between dynamics on the nodes and topology of the network leads to equilibrium networks which are typically not efficient and are characterized, as observed in empirical studies of R&D networks, by sparseness, presence of clusters and heterogeneity of degree. In this paper, we analyze the relation between the growth rate of the knowledge stock of the agents from R&D collaborations and the properties of the adjacency matrix associated with the network of collaborations. By means of computer simulations we further investigate how the equilibrium network is affected by increasing the evaluation time τ over which agents evaluate whether to maintain a link or not. We show that only if τ is long enough, efficient networks can be obtained by the selfish link formation process of agents, otherwise the equilibrium network is inefficient. This work should assist in building a theoretical framework of R&D networks from which policies can be derived that aim at fostering efficient innovation networks.

1. Introduction. The field of Network Theory has only recently focused its attention on the study of dynamic models in which the topology of the network endogenously drives the evolution of the network. These models assume that the evolution of the links in the network is driven by the dynamics of a state variable, associated to each node, which depends, through the network, on the state variable of the other nodes [22, 47]. Such an interplay is crucial in many biological systems and especially in socio-economic systems. In biological systems, a Darwinian selection mechanism usually works at a global level: for instance in the context of networks, one can think of a mechanism in which the least fit nodes are replaced (together with their connections) with new nodes that are randomly connected to the remaining nodes [34, 33, 6]. In socio-economic networks, besides the global selection mechanism, there exists a “local” selection mechanism: the nodes in fact represent agents that form or delete links with other agents, based on the utility that those links may provide to them [41, 28, 8].

The foregoing issue has also attracted researchers in computer science [39, 18, 11] as well as social scientists and economists [32, 1, 2, 25, 26] In particular, the study of networks has become increasingly important in the literature on R&D networks

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