The Evolution of Patent Innovator Networks: The Dynamics of Structural Characteristics and Link Formation

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Networks have attracted considerable attention in the last decades. Works from a broad spectrum of scientific research have revealed that networks in quite diverse areas of life (e.g. the living cells, the world wide web, social relationship networks, etc.), although different at the first sight, share some basic common properties, among which the most striking is their invariant scale-free characteristics.
At the same time the literature on innovation has focused on learning and innovation networks, i.e. networks of firms, researchers, specialized institutions etc. It is now clear that innovation can be regarded as an interactive process which requires relationships between different agents of the process (innovators, firms, universities, venture capital, etc.).
These two lines of research have been synthesised in the area of innovation networks which tries to reveal the characteristics and dynamic patterns of such networks. The work in this field has proceeded along two different methodological avenues. First, empirical studies made considerable efforts to gain insight into the characteristics of real innovation networks. These studies however, mainly due to the lack of adequate data, grasp only a static view of the networks in question, their structural characteristics and the relationship between these characteristics and their performance.
On the other hand, simulation studies (constituting the theoretical background of network analysis), has focused more on dynamic issues, i.e. the evolution of networks. Simulation studies gained relevance in this field as network models can be rarely handled analytically. However, simulation studies can be separated into two categories. The first category consists of such experiments which are linked to empirical studies some way and the other category consists of purely theoretical model simulations. Only the latter type of simulations treats explicitly the dynamic evolution of networks.
In this paper we would like to bring these two areas of research one step closer. Using a very extensive database covering patent statistics of European countries through the period between 1978 and 2005 we analyse the dynamics of patent inventor-networks in 6 high-tech subsectors. Based on the results of this empirical study we analyse the hypotheses of a simulation model considering dynamic issues in evolving networks. Moreover, we calibrate the model according to the data which this way is able to replicate the dynamic behaviour of the evolution of patent inventor networks.
The empirical part of the paper places attention on the evolution of patent innovator networks in high tech subsectors of European countries through more than 20 years. First, we focus on the structural dimensions of patent innovator

networks analyzing the evolution of such characteristics over time. Then we turn to the question of link formation, examining the main forces behind the selection of partners according to their current situation in the network as well as their geographic location.

The simulation part of the paper presents a straightforward extension of the Barabási-Albert model of network evolution. Their model presents a simple algorithm based on growth and preferential attachment which generates scale-free networks. In our approach, first we demonstrate that preferential attachment is not a necessary condition for an evolving network to become scale-free, but simply the presence of growth implies the scale-free property. Second, we extend the Barabási-Albert model by imposing locality-constraints on link-formation. Agents in the network not only consider the connectedness of other agents when building new connections, but their distance in the network: links are more likely to form locally than trough large distances. Through local attachment the resulting networks become more clustered than through preferential attachment, although the scale-free property of the networks is still present. In the simulation the weight of preferential and local attachment can be varied. Through the empirical analysis we try to reveal that in the case of high-tech innovator networks which forces are in work during network evolution.

Most part of the above is still work in progress, so we lack adequate, clear cut results yet.