The Dynamics of High-Tech Clusters: Competition, Predation, Synergies[1]

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> "Precisely why particular technologies cluster is not well understood. Innovations often occur in more than one location at about the same time; largely because of different environmental conditions, however, commercial exploitation flourishes in a much smaller number of places. Powerful agglomeration advantages develop in the specialised technopolis. Supplier and service firms arise to serve the growing industry (...). Firms that represent downstream markets join the cluster. A specialised labour market forms, which reinforces the growth of the industry (which, in turn, attracts more specialised labour). Local educational and research institution collaborate with industry to develop programs to meet the need of the industry. University thus develop national and international reputation for excellence in the specialised field of the regional industry. In mature technopolises, diversification of the industrial base occurs (as) a natural consequence of the agglomeration process and linkages among certain technologies. (...) The large technical labour force attracts other industries that demand skills similar to those needed by the core industry. (...) Service industries that arose to meet the demand of local industry find export markets and become an independent source of growth for the technopolis. Universities and other research institutions sometimes broaden their areas of specialisation and generate new growth in new fields."
> R.W. Preer (1992), *The Emergence of Technopolis*, Praeger, New York

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1. Introduction

The causes and effects of the spatial clustering of firms within a given industry have been suggested as a research question to economists by Marshall (1920) but later forgotten by the economic profession. Seventy years later, Krugman (1991) gave new emphasis on the spatial aspect of firm behaviours and his contribution spurred a new surge in what has been defined as the "New Economic Geography" literature.

Aim of this paper is to apply an original theoretical framework, derived from population ecology, to the analysis of the development of high-tech cluster in the US in order to underline the interplay of agglomeration economies and diseconomies in the growth process of a cluster and to stress the complex and different (i.e. synergic, competitive, etc.) interactions which exists between different high-tech industries, within the same states, and between different states within the same industry. The formal model is able to identify and discuss the existence and stability conditions of long run equilibria through a graphical analysis (phase diagrams).

2. The Population Ecology Approach

While we refer to previous works (Maggioni 1993, 1994, 2002a) for the discussion of the micro-foundation of population ecology models applied to firms' location decision and clustering dynamics, here we will briefly illustrate a number of possible different patterns of interactions which may emerge between two "populations" of firms with special emphasis on long-run dynamics and to the stability/instability of equilibria.

According to the population ecology approach, the development pattern of an industrial cluster is jointly determined by two distinct but interrelated processes: an inner dynamics (driven by the number of firms already located in the cluster) and an external dynamics (driven by the spatial and industrial interaction between and within clusters).

2.1. Clusters' Growth and Size

In the population ecology literature, a generic modelling framework describes the growth process of a given population (in our case of firms belonging to a certain industry and locating in a given area) as a differential equation (or, more often, a system of differential equations) which describes the changes over time of a variable (i.e. the population net growth) as function of: the level of the same variable (the size of the population) at each moment in time; a ceiling level (which takes into account the limit imposed by the available amount of resources); and the level of other variables (which represent the interacting populations).