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Estimation of evolutionary models as a tool for research in industrial organization

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Abstract

This paper develops a structural evolutionary microeconomic model where the forces of chance and selection are at work and matches this model to data. As a concrete example we explore the process of industry concentration by modeling bottom-up starting with profit maximizing firms and introducing stochastic elements at various levels of the market. An estimation procedure is developed to connect the model to data of the U.S. household laundry equipment industry. The results for the structural model are then contrasted to a version of Gibrat's model estimated with the same approach. It turns out that the structural model provides a more accurate account of the historical data. This indicates that capturing links between firms operative through the market mechanism promises a more accurate assessment of the future course of concentration of an industry.

JEL classification: C150; D410; L600; L680

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1. Introduction

The process of economic change is the outcome of both *chance* as well as of the internal *structure* (i.e., the mechanisms or processes) of the entity under consideration such as the firm, the industry or the economy as a whole. Nowhere has this become clearer than in the field of industrial economics. Specifically, the analysis of the *concentration* process of an industry is the subject of a large literature (see Curry and George, 1983, for a survey). Chance as the primary

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determinant of the concentration process has been explored in a stochastic tradition starting with Gibrat (1931). Sutton (1997) offers a good survey of this research. This first strand of the literature dealing with concentration starts with measures (or assumptions) regarding the distribution of firm growth and investigates the likely outcome of this process over time. Typically, these studies do not explicitly model market mechanisms.[1] Mechanisms and processes are the key elements in another strand of research on industry concentration. Analyzing the determinants of market share instability and the role of innovation in the concentration process Nelson and Winter (1977), Silverberg et al. (1988) and Mazzucato (1998, 2000) have modeled interdependencies of firms. These contributions to dynamic economics (typically labeled evolutionary economics) strongly depend on the tool of computer simulation. The inclusion of chance elements threatens to make the interpretation of evolutionary models even more difficult given that simulations already offer insights of less generality when compared to the study of analytic models (as, e.g., noted by Nelson and Winter, 1977).

The present study proposes a way of stochastic evolutionary modeling that avoids these problems. We explore market functioning by modeling bottom-up starting with profit maximizing firms and introducing stochastic elements at various levels of the market. Then, instead of an ad hoc specification of the relative magnitudes of these random influences we propose an estimation procedure that allows us to quantify these stochastic influences based on historical data.[2] With this procedure stochastic simulation of evolutionary models is made into a tool for the empirical analysis of market phenomena. As an application of this procedure we study the historical development of a particular U.S. industry. Finally, we empirically compare the results of this structural evolutionary analysis to a model in the Gibrat tradition. Stochastically simulated paths based on Gibrat's model have been analyzed previously (see, e.g., Scherer and Ross, 1990, pp. 141–143; McLoughan, 1995). Scherer et al. (2000) extend the Gibrat model to make simulated industry concentration paths conform better to empirical observations. Contrary to these simulations in the literature we apply the same estimation approach to the Gibrat model as that proposed for the structural model. The comparison of models favors the structural evolutionary variant over the Gibrat variant.

2. The model

We undertake to analyze a perfectly competitive industry. In consequence, concentration in this model is not linked to issues of monopoly power. Moreover, the analysis abstracts from innovations. These choices are purely pragmatic: they allow us to build and estimate a manageable model of the concentration process. For some industries this is a realistic model. For other industries where, for example, competitors form a cartel at some point in the concentration process or where innovation is important the present analysis should be seen as the starting point for a more elaborate model. In order to study the interplay of structure and chance we build a model from bottom up starting with the single firm. The individual firm produces a homogenous good with a production function exhibiting at a given point in time decreasing returns to scale. Specifically, we assume that costs rise with the square of output. However, the production process and hence also the production function are variable: firms can change their production technology (and hence

[1] One exception is the study by Simon and Bonini (1958) who investigate the link between firms' cost structure and the stochastic determination of the size distribution of firms.

[2] This approach has parallels in contributions by Pagan (1994), Hansen and Heckman (1996), and Gili and Winker (2003).