Spatial competition and price formation

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Abstract

We look at price formation in a retail setting, that is, companies set prices, and consumers either accept prices or go someplace else. In contrast to most other models in this context, we use a two-dimensional spatial structure for information transmission, that is, consumers can only learn from nearest neighbors. Many aspects of this can be understood in terms of generalized evolutionary dynamics. In consequence, we first look at spatial competition and cluster formation without price. This leads to establishement size distributions, which we compare to reality. After some theoretical considerations, which at least heuristically explain our simulation results, we finally return to price formation, where we demonstrate that our simple model with nearly no organized planning or rationality on the part of any of the agents indeed leads to an economically plausible price. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Econophysics; Economics; Simulation; Markets

1. Introduction

There are several basic concepts which lie at the heart of economic theory. They are the "economic atom" which is usually considered to be the individual, profits, money, price and markets and the more complex organism the firm. Much of economic theory is based on utility maximizing individuals and profit maximizing firms. The concept of a utility function attributes to individuals a considerable amount of sophistication. The proof of its existence poses many difficult problems in observation and measurement. In this study of market and price formation we consider simplistic social individuals who must buy to eat and who look for where to shop for the best price. In this foray

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into dynamics we opt for a simple model of consumer price formation. Our firms are concerned with survival rather than a sophisticated profit maximization. Yet we relate these simple behaviors to the more conventional and complex ones.

A natural way to approach the economic physics of monopolistic competition is to introduce space explicitly. For much of economic analysis of competition space and information are critical factors. The basic aspects of markets involve an intermix of factors, such as transportation costs and delivery times which depend explicitly on physical space. But for pure information, physical distance is less important than direct connection. For questions concerning the growth of market areas, the spatial representation is appropriate. Consideration of space is sufficient to provide a justification of Chamberlin's model of monopolistic competition as is evident from the work of Hotelling [1]. Furthermore, it is reasonably natural to consider space on a grid with some form of minimal distance. Many of the instabilities found in economic models such as the Bertrand model are not present with an appropriate grid.

When investigating these topics, one quickly finds that many aspects of price formation can be understood in terms of generalized evolutionary dynamics. In consequence, our first models in this paper study spatial competition and cluster formation without the generation of price (Section 3). This generates cluster size distributions, which can be compared to real world data. We spend some time investigating theoretical models which can explain our simulation data (Section 4). We then, finally, move onto price formation, where we implement the price dynamics "on top" of the already analyzed spatial competition models (Section 5). The paper is concluded by a discussion and a summary.

2. Related work

The model is an open one related to the partial equilibrium models of much of micro-economics. In particular, money and its acceptance in trade is taken as a primitive concept. There is literature available on the acceptance of money both in a static equilibrium context (see for example Ref. [2]) and in a "bootstrap" or dynamic context (see for example Refs. [3,4]). These are extremely simple closed models of the economy where each individual is both a buyer and seller. Eventually we would like to construct a reasonable model where the acceptance of money, the emergence of competitive price and the emergence of market structure all arise from the system dynamics. This will call for an appropriate combination of the features of the model presented here with the closed models noted above. We do not pursue this further here. Instead by taking the acceptance of money as given our observations are confined to the emergence of markets and the nature of price. The static economic theories of monopoly and mass homogeneous competitive equilibrium provide natural upper and lower benchmarks to gauge market behavior. The intermediate zone between when n is 2 and when n is very large is covered in the economic literature by various oligopoly models, of which those of Cournot [5], Bertrand [6] and Chamberlin [7] serve as