Nonlinear Dynamics in Economics, Finance and the Social Sciences

Essays in Honour of John Barkley Rosser Jr

Bearbeitet von
Gian Italo Bischi, Carl Chiarella, Laura Gardini

1st Edition. 2010. Buch. xv, 384 S. Hardcover
ISBN 978 3 642 04022 1
Format (B x L): 15,5 x 23,5 cm
Gewicht: 1630 g

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Foreword

This edited volume contains a collection of selected and refereed papers presented at the Fifth MDEF Modelli Dinamici in Economia e Finanza (Dynamic Models in Economics and Finance) International Workshop held at the Department of Economics and Quantitative Methods of the University of Urbino, Italy, on the 25th–27th of September, 2008.

It is true without doubt that scientific meetings derive their value not only from the scientific results presented during the formal sessions, but also and perhaps more importantly from the atmosphere created amongst the participants during the breaks and dinners that afford them the opportunity to meet again with old friends and make new ones. In that respect we are happy that the fifth MDEF meeting gave us the opportunity to pay tribute to **John Barkley Rosser, Jr**, an outstanding scientist and good friend of many of the participants, who celebrated his sixtieth birthday in 2008.

We shall not attempt to give a full list of Barkley's numerous scientific achievements here; we shall only mention his important contributions to various areas that fall within the focus of the Workshop, in particular, his work on the importance of nonlinearity and complexity in the economic sciences. With some of his earliest work on these topics appearing in the 1980s, it would be fair to say that Barkley has been one of the pioneers in the area. The first edition in 1991 of his book *From Catastrophe to Chaos: A General Theory of Economic Discontinuities* brought together and gave a perspective on many of the early contributions. This book, and its second edition in 2000, had a profound influence on many researchers who have contributed to nonlinearity and complexity in the economic and social sciences over the intervening two decades. As one would expect of a scholar who has very broad and eclectic interests, Barkley's influence extends beyond the area in which he originally made his name, and he has made contributions to areas such as the new traditional economy, econochemistry, the megacorpstate, economic inequality and the underground economy. No doubt because of his contributions across so many areas, Barkley assumed the role of Editor of the *Journal of Economic Behavior and Organization* in 2001. In an era when many top journals seem to be more and more closed to new or different ways of thinking, this journal remains open to new and innovative ideas in the economic and social sciences, and as such it provides the perfect foil for Barkley's very broad range of interests.

After completing a bachelor's degree with a major in economics and a minor in mathematics, Barkley completed his master's and doctoral degrees in economics, all at the University of Wisconsin-Madison. He has built his entire career with the Department of Economics at the James Madison University, which he joined in 1977 and where he has occupied various positions. In 1996, Barkley was appointed as the Kirby L. Cramer Jr. Professor of Business Administration, a position that he still occupies.

The fifth MDEF workshop was held in a period of severe global economic crisis, probably the worst since the 1930s. The crisis has not only brought about widespread influences on social and economic life in many countries, but also poses a challenge to what had developed as the mainstream economic consensus from about the mid-1970s. This challenge is highlighted by the fact that in order to manage the crisis, policy makers in the major economies have had to adopt policies that run counter to the principal tenets of that mainstream orthodoxy. It therefore seems very apposite against this backdrop to hold a workshop on issues devoted to complexity, nonlinearity and heterogeneity in economic science, and that the workshop should be dedicated to Barkley who has been at the forefront in criticising the mainstream orthodoxy and developing new ways of thinking about economic science.

The papers that appear in this volume deal with a number of different topical areas involving the application of concepts from the theory of nonlinear dynamical systems, from dynamic models that describe the interactions between economic activities and the environment, a topic that has been repeatedly stressed in many papers and books by Barkley, to the description of the wild dynamics of financial markets, both through deterministic as well as stochastic models. There is also a set of papers dealing with strategic interaction in economics and the social sciences by the use of the methods of game theory, as well as some contributions on markets with heterogeneous agents or models dealing with expectations and learning in economic systems, an issue that is currently topical in economics, finance and the social sciences. Some applications of deterministic dynamical systems to business cycles and labour markets are also presented, as well as dynamic oligopoly games and nonlinear evolutionary games for the description of social systems and the sustainable exploitation of natural resources. Such a broad spectrum of applications, as well as the various mathematical methods used to analyse the corresponding models, are intended to give some perspective on the different streams of the growing literature in this field. It is thereby our hope that this special volume will stimulate further collaborations amongst researchers from different fields, through a fruitful trade-off between theoretical issues and applications. We hope, furthermore, that this special volume will help the reader to gain an entrée into the main topics in nonlinear dynamics applied to economics, finance and the social sciences, as well as their recent advances.

We now give, for the convenience of the reader, a brief review of the twenty contributions, chosen after a careful selection and revision, in order to give a broad idea of the kind of dynamical models proposed, the mathematical methods used, and to show how they reflect some common themes and features.

In the first paper, Antoci and Borghesi propose a two dimensional evolutionary game in continuous time, to describe a perverse effect by which environmental degradation may induce agents to adopt self-protection strategies that generate negative externalities by further increasing environmental degradation. The second paper, by Antoci, Russu and Ticci, considers a model of a small open economy in order to mimic the situation of developing countries where economic agents differ not only with respect to income, but also with respect to their vulnerability to environmental depletion. Their model takes into account two main factors that have been partially neglected by the economic development literature: the environmental externalities of human activity and agent heterogeneity in terms of asset endowment and, consequently, in terms of income source and vulnerability to depletion of natural resources. In a similar vein, the paper by Antoci, Naimzada and Sodini proposes an overlapping generations model, a quite natural framework in which to represent problems of sustainable development (a typical intergenerational issue), to analyse possible feedback effects on environmental degradation, consumption and economic growth. Another important topic in environmental dynamics (on which Barkley Rosser has written many interesting papers) is the commercial exploitation of natural renewable resources, such as fisheries. This is also the topic of the paper by Gu and Lamantia, where a discrete-time dynamic model is proposed to model different harvesting policies of a single species with age structure, where the exploiters can compete or cooperate, so that they can try to maximize the profit of a coalition instead of the individual profit.

The paper by Marta Biancardi investigates the stability of international agreements for environmental protection in a dynamic model of emissions reduction where the countries involved in the agreement determine their abatement levels in a dynamic setting, given the dynamics of pollution stock and the strategies of the other countries. The problem is studied in a differential game setting. Also in a dynamic game framework, Giovanni Villani analyzes a model of R&D cooperation where strategic alliances that create synergies are considered, and additional information increases the probabilities of success of R&D projects, where firms are divided into leaders and followers and R&D investments are assumed to be characterized by positive network externalities that induce more benefits in case of reciprocal R&D success. Within the theme of leaders and followers and in the framework of dynamic oligopoly models, Tönu Puu makes an important contribution with his attempt to unify the Cournot and Stackelberg approach, where a Cournot duopolist can shift to Stackelberg leadership if too disappointed by current profits. Issues on strategy-switching dynamics are also analyzed from a general point of view, by Weihong Huang, who applies his results to explore the significance of adopting price-taking strategy in a quantity-competed oligopoly. R&D public expenditure and knowledge spillovers are considered in the paper by Commendatore, Kubin and Petraglia, who propose a dynamic capital model with publicly financed R&D activities under alternative assumptions on the intensity of knowledge spillovers, and obtain new results about global stability properties of boundary equilibria. The dynamics in non-binding procurement auctions, with boundedly rational bidders, are considered by Colucci, Doni and Valori, who study a procurement auction game where buyers

rank different bids on the basis of both the prices submitted and the quality of each bidder, which is their private information. These authors assume that bidders have bounded rationality because they form expectations on market price rather than on the best price of competitors and also because they update expectations adaptively.

A general analysis of delay differential nonlinear economic models is provided by Matsumoto and Szidarovszky, who compare fixed and continuously distributed information lags and show that the two types of models generate identical local asymptotic behaviour when small delays with exponentially decreasing kernel functions are considered, whereas for large delays the asymptotic properties become quite different. They apply these general results to the business cycle models of Goodwin and Kaldor, augmented with a Kaleckian investment lag, and to a Cournot oligopoly model. The paper by Ferri and Variato studies the relationship between imperfect competition and economic fluctuations in a macro model with uncertainty. In such a model, imperfect knowledge economics suggests that the relationships between the agents and the environment become complex, while a learning process capable of generating endogenous dynamics takes place. Colombo and Weinrich analyse persistent disequilibrium dynamics in a theoretical dynamical model involving temporary equilibria with quantity rationing in each period and price adjustment between periods. The resulting dynamic system may present a variety of dynamic behaviours, ranging from the convergence to stationary or quasi-stationary states, to complex or even chaotic dynamics. Fabio Privileggi analyzes the transition dynamics in a continuous time endogenous growth framework in which knowledge evolves according to the Weitzman recombinant process, and finds a suitable transformation for the state and control variables in the dynamical system diverging to asymptotic constant growth, so that an equivalent 'detrended' system converging to a steady state in the long run can be tackled. An interesting application of continuous-time stochastic dynamic modelling with optimal control is provided by Longo and Mainini, who study a model of electoral competition, where elections serve as a device for selecting talented politicians, by using dynamic programming techniques. Saltari and Travaglini propose a behavioral approach to portfolio choice by adopting the theory of disappointment aversion to show how disappointment aversion affects the optimal portfolio choice when risk is small. Indeed, the standard portfolio model predicts a large equity position for most households, whereas empirical evidence shows however that household wealth is characterized by a small proportion of risky assets. To solve this paradox, the authors employ the axiomatic theory of disappointment aversion.

Finally, some applications of dynamic modelling to the description of financial markets complete the spectrum of new trends of nonlinear dynamics contained in this book. Of course, the development of new mathematical approaches to simulate and control the dynamic behaviour of financial markets is particularly apt at a time characterised by a general financial crisis. For example, the paper by Frank Westerhoff proposes an agent-based financial market model where agents following technical and fundamental trading rules to determine their speculative investment positions interact and may decide to change their trading behaviour. Despite its simple mathematical structure, this model is able to replicate some salient features of

asset price dynamics. Along the same line, Tramontana, Gardini, Dieci and Westerhoff consider a three-dimensional nonlinear dynamic model of interacting stock and foreign exchange markets jointly driven by the speculative activity of heterogeneous investors, and give a global dynamic analysis by using analytical and numerical tools. A heterogeneous Capital Asset Pricing Model (CAPM) is proposed by Chiarella, Dieci and He, where agents are assumed to form optimal portfolios based upon their heterogeneous beliefs about conditional means and covariances of the risky asset returns, and in this framework they are able to obtain the exact relation between heterogeneous beliefs and the market equilibrium returns. The impact of the dynamics of interest rates of a Central Bank on the behaviour of commercial banks is analyzed in the paper by Casellina and Uberti, which takes into account the expectations of economic agents. Their model is calibrated by the VAR approach on Italian quarterly data from 1990 to 2007.

Before ending this foreword, we wish to thank the various academic colleagues around the world who have provided prompt and insightful referee reports on all the papers that were submitted to this special volume. Thanks are particularly due to Fabio Tramontana who greatly assisted the editors in putting the papers into the required Springer format. We would also like to express special thanks to Mrs Dr. Martina Bihn, the Springer Editorial Director, who facilitated the book's publication and carefully guided the entire editorial process. Finally, we thank all the participants at MDEF, whose efforts initiated a very interesting series of fruitful seminars, and who submitted so many interesting papers to us.

Urbino, Italy — Gian Italo Bischi
Sydney, Australia — Carl Chiarella
Urbino, Italy — Laura Gardini