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Guest Editor's Introduction

1.1

The tremendous development of and easy access to computational power within the last 30 years has led to the widespread use of numerical approaches in almost all scientific disciplines. Nevertheless, while for example the engineering sciences focused on the applied use of simulation techniques from the very beginning, in the social sciences most of the early examples of numerical approaches were purely theoretical.

1.2

There are two reasons for this. First, since the middle of the 20th century, starting with economics, equilibrium-oriented analytical techniques flourished and were developed to a highly sophisticated level. This led to the widely shared view that within the elegant and formal framework of linear analysis offered by neoclassical economics, the social sciences could reach a level of accuracy not previously thought to be possible.

1.3

Second, within the same period, new phenomena of structural change exerted a strong influence on the social and economic realms. Despite the mainstream neoclassical successes in shifting the social sciences to a more mathematical foundation, an increasing dissatisfaction with this approach emerged. For example, by the 1970s the benchmark of atomistic competition in neoclassical economics had already been replaced by the idea of monopolistic and oligopolistic structures under the heading of workable competition (e.g. Scherer/Ross, 1990). A similar development emphasising positive feedback effects and increasing returns to scale caused by innovation led to the attribute "new" in macroeconomic growth theory in the 1980s (Romer, 1990).

1.4

In addition to these stepwise renewals of mainstream methodology, an increasingly larger group claimed that the general toolbox of economic theory, emphasising rational behaviour and equilibrium, is no longer suitable for the analysis of complex social and economic changes. In a speech at the International Conference on Complex Systems organised by the New England Complex Systems Institute in 2000, Kenneth Arrow stated that until the 1980s the "sea of truth" in economics lay in simplicity, whereas since then it has become recognised that "the sea of truth lies in complexity". Adequate tools have therefore to include the heterogeneous composition of agents (e.g. Saviotti, 1996), the possibility of multilevel feedback effects (e.g. Cantner/Pyka, 1998) and a realistic representation of dynamic processes in historical time (e.g. Arthur, 1988). These requirements are congruent with the possibilities offered by simulation approaches. It is not surprising that within economics the first

numerical exercises were within evolutionary economics, where phenomena of qualitative change and development are at the front of the research programme.

1.5

The first generation simulation models were highly stylised and did not focus on empirical phenomena. Instead, they were designed to analyse the logic of dynamic economic and social processes, exploring the possibilities of complex systems behaviour. However, since the end of the 1990s, more and more specific simulation models that aim at particular empirically observed phenomena have been developed. Modellers have had to wrestle with an unavoidable trade-off between the demands of a general theoretical approach and the descriptive accuracy required to model a particular phenomenon.

1.6

In a European project on the Self-Organisation of Innovation Networks (SEIN), researchers from disciplines ranging from sociology, economics, and political sciences to theoretical physics have sought to develop a simulation tool to describe and analyse the emergence of innovation networks in different industrial sectors. The group wanted to invite scholars from the various fields of simulation to a conference to outline the different strands numerical analysis has recently taken. A conference on "Applied simulation analysis" was held on October 19th and 20th 2000 at the University of Augsburg in Germany and this is the origin of the papers in this special issue. During the conference it became clear that a single class of applied simulation models does not exist and there is a wide space of very different applications.

1.7

The first paper in this special issue, by Michael Möhring and Klaus Troitzsch, draws on a model already about 30 years old describing the eutrophication of a lake. Möhring and Troitzsch refine the earlier model in order to analyse multilevel interactions between users, decision makers and the natural environment. They introduce a simulation approach helpful in supporting planing agencies and policy makers in the complex field of managing ecological systems.

1.8

Wolfgang Kerber and Nicole Saam use the possibilities of multilevel simulation in order to introduce Hayek's concept of competition as a discovery process into a dynamic economic environment driven by firms aiming at increasing their market shares through innovation and imitation. Their approach sheds new light on the debate about the role of mergers and acquisitions and concentration within competition policy.

1.9

Günter Haag and Phillip Liedl investigate the multi-linked processes of innovation within firms, and knowledge generation and diffusion. In particular, their modelling approach combines elements of the theory of industrial organisation and macroeconomic growth theory with synergetics. This eclectic modelling strategy leads to new results with respect to knowledge diffusion and the timing of innovation.

1.10

Inspired by the notion of *history-friendly-models* coined by Franco Malerba, Richard Nelson, Luigi Orsenigo and Sidney Winter, the final four papers can be summarised under the heading of *topic-friendly-models*. Thomas Brenner studied the emergence of localised industrial structures with the help of numerical techniques. In his *geography-friendly-model* he draws on the stylised facts of industrial agglomeration by analysing their particular importance for the emergence of industrial clusters. Uwe Cantner, Bernd Ebersberger, Jens Krüger, Horst Hanusch and Andreas Pyka developed a simulation approach which can be labelled *macroeconomic-friendly*. By comparing non-linear regression with evolutionary programs for empirically deriving transition rates, they show that the stylised fact of twin peaks in the world income distribution can be explained using the knowledge-based approach of evolutionary economics.

1.11

Franco Malerba, Richard Nelson, Luigi Orsenigo and Sidney Winter outline the methodologies of their *history-friendly-modelling* approach by focusing on the example of the computer industry. The authors

aim to identify the crucial aspects behind the dynamics of industrial evolution. To make the outcomes comparable with the development observed in reality, it is clear that the relationships have to be modelled in a sector-specific way. Accordingly, such an approach will need to create many different models for different industries, although these will nevertheless share common features. The last paper of this special issue deals with the SEIN approach to modelling the emergence and dynamics of innovation networks. The approach of Nigel Gilbert, Andreas Pyka and Petra Ahrweiler can be described as a policy-friendly-model because the simulation program offers a platform which, on the one hand, allows the modelling of different empirical cases and, on the other hand, allows the analysis of the impacts of specific policy measures undertaken to spur innovation processes.

1.12

Finally, this introduction offers an opportunity to thank some people and institutions that contributed significantly to the success of the conference. I thank the local host, Horst Hanusch, for hospitality in Augsburg, and the discussants who were responsible for intensive discussion during the scientific programme. Many thanks also to the sponsors: Clariant GmbH (Gersthofen), IHK Innotec GmbH Augsburg, Zeuna-Stärker GmbH (Augsburg) and the Raiffeisenbank Neu-Ulm. Without their funding, the organisation of such a conference would not have been possible. Finally, I would like to express my thanks to Nigel Gilbert for his patient assistance in editing this special issue.

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Return to Contents of this issue