JASSS

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The Methodology of Simulation Models: Chances and Risks

1.1

In recent years more and more social scientists and in particular economists have been using simulation models. Without doubt numerical approaches—among them most outstanding agent-based approaches—offer a prolific way out of the tight corset which is determining modelling strategies so far for economists (e.g. Pyka and Fagiolo 2007). Accordingly, simulation techniques are applied almost enthusiastically, because they allow modelling economic problems like e.g. interactions of heterogeneous agents on developing markets appropriately. In particular, economists who dealt with innovation and inherent uncertainty have been interested in the tools provided by simulation models. They were dissatisfied with traditional modelling that required a very restrictive set of assumptions, in particular identical agents deciding rationally, thereby inevitably leading to a deterministic representation of innovation. In contrast, economists modelling innovation were satisfied with simulation models that can emulate heterogeneous agents driving the evolution of economic systems and allowing the consideration of true uncertainty.

1.2

The huge success of simulation models in economics comes with a price. Nowadays, we face an almost maze-like variety of set of assumptions in simulation modelling (e.g. Brenner and Werker 2007). As a consequence, most methodological issues remain implicit so that even in the community of simulation modellers severe doubts about the results and usability of other scholars' simulation models are discussed. At the same time entrepreneurs and policy makers call for insights of models representing our increasingly complex and complicated global environment. For that reason, we here focus on *recent developments in computer sciences opening up modelling opportunities, the set-up and the empirical validation of simulation models* as well as *the use of simulation models for consulting entrepreneurs and policy makers.*

1.3

Economists' preference for simulation models stems from *recent developments in computer sciences.* In particular the ever increasing speed of data processing as well as the substantial

improvements of simulation software opened up more and more opportunities of modelling economic phenomena, which economists could not achieve with former versions of hard- and software. To make use of the recent developments in computer sciences, economists need more and more knowledge on the recent developments in this field. Bandini, Manzoni and Vizzari (in this Special Section) provide this kind of knowledge by linking economics and computer sciences in two ways. First of all, they show which kind of economic questions can be represented by which kind of agent-based simulation models. Second, they give insights in how to interpret the results stemming from these exercises.

1.4

When *setting-up and empirically validating models* economists always face the problem to decide of how simple and how descriptive the model should be. Edmonds and Moss (2004) sharpen this discussion by contrasting the so-called KISS (keep it simple, stupid) with the KIDS approach (keep it descriptive, stupid). For practical reasons traditional modelling tools drove economists to the KISS approach, because they limited the models to analytically solvable problems. The set-up and the use of data were restricted accordingly. In contrast, simulation techniques have opened up models beyond analytically solvable problems, thereby making simplification of models for mathematical reasons no longer necessary.

1.5

Keeping a model simple and thus following the KISS approach has its merits – even if there is no need to simplify simulation models for practical mathematical reasons (Pyka and Deichsel, this Special Section). Imagine the extreme example of you choosing to draw a map to a scale of 1:1 for driving your car from Hohenheim to Delft. This would mean that you would have to include every single road irregularity, tree, etc. in your map. Although all information provided by this map might turn out to be useful in a single circumstance and can even prevent a serious accident, eventually, your map would be completely useless, because you could not identify your way better than in the real world. For modelling, this means that also agent-based simulation models need a high degree of abstraction to represent complex and complicated relationships in order come up with meaningful results. Therefore, Pyka and Deichsel suggest starting by keeping the model as simple as possible (the so-called KISS approach: "keep it simple, stupid") without, of course, abstracting away from the necessary degree of complexity to capture the core of the problem under investigation. They start with reinterpreting Milton Friedman's classic methodological text as the basis of the KISS approach and by this place his methodological considerations into the timely context of agent-based simulation modelling. Based on an analysis and a critique of Friedman's work they provide some guidelines of how to simplify simulation models while at the same time keeping the complex structure of the economic problem in order to allow for a better understanding of the underlying causal relationships.

1.6

Keeping the model as descriptive as possible and thus following the KIDS approach is advantageous when economists want to *give advice to entrepreneurs and policy makers* with the help of simulation models. Simple models using the KISS approach are not very useful in this context, as they have problems to integrate empirical data and therefore are mostly relying on theoretical reasoning. Brenner and Werker (this Special Section) suggest using as much empirical data as possible for setting-up and testing simulation models. They

recommend to model what cannot be covered by data by either logical considerations or by keeping the models structure as general as possible. Models designed in such a way mirror economic processes in a rather detailed way. This gives economists ample opportunity for experiments showing the results of the behaviour of entrepreneurs and policy makers. Such kind of so-called abductive simulation model results in concrete and meaningful suggestions for policy and management and allows an easier transfer and application of the insights generated by the models due to their lower levels of abstraction.

1.7

Dawid, Gemkow, Harting and Neugart (this Special Section) provide an interesting example of how to combine the KISS and KIDS approach. They start with a simple model of two regions that are connected by the markets for investment goods and for labour. Then, they extend the model stepwise and identify the used parameters empirically. Thereby, they can reproduce the stylised facts known from former empirical investigations of modern labour market economics. The model is constructed in such a way that it becomes more and more real by integrating markets of finance and the public sector. In its final state the model can be used *for policy experiments and advice.*

1.8

Yücel and Van Daalen (this Special Section) provide an overview of how policy activities can be matched to model types of different natures, namely analytical, advisory, strategic, mediation, participatory and discussion models. Based on that, they discuss how to assess these at different stages, namely setting them up, testing and using them. In doing so, they provide a structured discussion that can serve as *methodological guideline for economists, policy makers and entrepreneurs.*

1.9

As a conclusion of this Special Section we would like to suggest that the potential trade-off between KIDS and KISS approaches towards agent based simulation techniques can be considered as a misunderstanding. Like convincingly shown already by Edmonds and Moss (2004) this is not necessarily the case. The misunderstanding stems from the traditional way of setting up models in economics, which had to be simple in order to be manageable and framed within the standard set of assumptions. However, this is not the case for simulation— leaving us with the situation choosing the level of simplicity guided by content and not by mathematics. This does not necessarily mean that we now have to turn to extremely complex and complicated simulation models. We would rather suggest thinking quite carefully about what kind of models fit what kind of purposes best. There are already a few analyses concerning this issue (e.g. Brenner and Werker 2007, as well as Yücel and Van Daalen, this Special Section). However, there are numerous methodological questions that still have to be answered and which have to be put on the agenda for future research on the methodologies of agent based simulation techniques in social sciences.

🌍 References

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