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Art or science? The challenges of publishing peer reviewed papers based on linked models

Kunst oder Wissenschaft? Möglichkeiten und Grenzen der Veröffentlichung von wissenschaftlich begutachteten Beiträgen auf Grundlage von Modell-Netzwerken

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Abstract

The methodology used in a linked model system is generally too voluminous and of insufficient interest to form the basis of a peer-reviewed journal article. To be readily acceptable to an economics journal, the simulation results should provide economic insight and contribute to the economics literature.

Key words

quantitative integrated assessment; empirical models; "black box"

Zusammenfassung

Die bei einem verbundenen Modellsystem verwendete Methodologie ist im Allgemeinen zu umfangreich und von nicht hinreichendem Interesse, um die Grundlage für eine Veröffentlichung in wissenschaftlich begutachteten Zeitschriften bilden zu können. Voraussetzung für die Akzeptanz in wirtschaftswissenschaftlichen Zeitschriften ist, dass die Modellergebnisse neue ökonomische Einblicke liefern und zum wissenschaftlichen Erkenntnisfortschritt beitragen.

Schlüsselwörter

quantitative integrierte Beurteilung; empirische Modelle; „Black-Box"

1. Introduction

"Quantitative integrated assessment" involves linking simulation models, often across disciplines, in order to evaluate complex natural and human systems (ANTLE and CAPALBO, 2001: 389). In recent years, agricultural economists have been increasingly challenged to analyse broad and complex issues like multifunctionality, sustainability, rural development and biosecurity. These issues require a policy perspective that recognises not only the multiple stakeholders and conflicting objectives involved, but also the interactions between biophysical processes and the human decisions that impact on them, whether purposively or unintentionally. This has stimulated attempts at linking models, each of which depicts an individual component of the whole system. The aim is to improve understanding of long and complex causal chains and feedback mechanisms, and to compare the performance of alternative policy interventions that might occur at different points in the system. These simulation systems are structured as a set of linked models either because they harness together model components that were originally built as stand-alone reductionist models, or because they are designed from the outset to have a modular structure, in order to achieve greater efficiency and flexibility in the construction or operation of the simulation system.

An early, relatively small-scale example is the ECECMOD system (VATN et al., 1997), which links models of crop growth, hydrology, nutrient turnover, erosion and farm management, and has been used to simulate various policies for controlling nonpoint-source pollution in a watershed. The component models of ECECMOD operate at different levels of disaggregation (sub-field, field, farm) and their results are then aggregated to watershed level. A current, large-scale initiative is the SEAMLESS[1] Integrated Framework (see, for example, ITTERSUM et al., 2008), covering the countries of EU-25, drawing on various databases (including the European soil map, GIS-managed climate data, FADN, Eurostat and GTAP), modular in structure, and designed to perform *ex ante* assessments of agricultural and agri-environmental policies and technologies at scales ranging from field–farm to region or the EU as a whole.

Increasing amounts of research time and expertise are being devoted to developing and managing such linked systems, whose principal end-users are policy makers. In this paper, I address the question of whether and how researchers can also bring this work into the refereed journal literature, given the pressures that prevail throughout the research community to obtain scientific recognition by publishing in these fora. I shall not discuss strategies for publishing work based on individual (discipline-specific) model components in disciplinary journals, or for reporting technical solutions to problems of model linkage *per se*, which if novel and "re-usable" should find an outlet in journals specialising in computational methods or systems design. Instead, I shall discuss the scope for publishing the methodology and/or the simulation output of the *linked* simulation system. Moreover, my reflections will relate specifically to *economics* journals, for two reasons. The first reason is that I was invited to prepare this paper for a congress of agricultural economists, who formed the greater part of the original audience. The second reason is that, in view of the underlying societal and political demands driving the perceived need for these linked simulation systems, it is inevitable that the task of synthesising, interpreting and evaluating the results of quantitative integrated assessments should fall especially to economists.

1 System for Environmental and Agricultural Modelling, Linking European Science and Society.

2. The challenge

The title of the paper suggests an assumption that *linked* models might pose particular challenges for authors wanting to publish their work in peer reviewed journals. In fact, it is hard to identify any specific problems that arise simply because models are *linked*. The real challenge of publishing this type of work arises because of the *size* of the resulting simulation systems and the *purpose* for which they have been constructed. A large-scale model has an underlying philosophy, giving rise to a more or less coherent modelling strategy and structure, which can be summed up in a few pages. This is, however, overlaid by a huge number of operational details, ranging from the standard features common to all simulation models to highly *ad hoc*, model-specific, context-dependent, purpose-constrained elements. All these detailed features potentially affect the performance of the model. Reviewers and readers want to be able to open the black box containing this material in order to understand, interpret and evaluate it – but it cannot be presented within the scope of a journal article.

We might think the problem is easily solved if the model is already fully written up in an accessible technical report, or if its detailed specification is available on the Internet. These sources can be referenced in the paper and consulted by the referees and readers. But this apparent solution reveals a second problem. The economic theory embodied in these models is usually quite basic and unremarkable. In fact, the essential creativity of the work lies precisely in the relentless ingenuity and problem-solving expertise that have gone into constructing the model. If most of the technical material is removed from the paper and replaced by a citation, what remains are the results of the simulated scenarios. Unfortunately, the appetite of good journals and their readers is limited for papers summarising printouts of the scenarios that are under discussion on the policy agenda of the day.

Good economics journals want to publish work that is interesting from an economic-theoretic point of view, that is generalisable and durable, and – most important - that produces new knowledge. By contrast, our large-scale models have been built for the purpose of analysing a context-specific, often quite narrow, range of policy choices. Can such models rise to the challenge of being generalisable, durable and interesting from an economic-theoretic point of view? And do they typically produce "new knowledge"? Most large-scale simulation models – whether partial or general equilibrium – are rarely validated over a run of past years. More often, they are calibrated to a base year, and subjected to a few sensitivity analyses. It follows that the specific numbers generated in simulations are usually not accompanied by any error margins or confidence intervals, and are of unknown reliability. Their value for policy makers is that they permit a *ranking* of the outcomes of different policies according to various criteria, and generate discussion and further analysis that can provide insight and enhance decision making. But is a set of such numbers worth publishing in a journal, destined for an international readership, that will sit on library shelves for 30 years?

It can be argued that these simulations are hardly different from doing comparative statics in a theoretical model, which is a kind of output that many scientific journals seem pleased to publish. When the interactive structure under study becomes too large and too complex for an analytical solution, is it not appropriate to resort to computational methodology and computable solutions? Moreover, it will be argued, large-scale simulation models can incorporate exogenous or endogenous dynamics that allow the tracing out of time-paths and adjustment effects that are beyond the capability of theoretical, analytically tractable models.

This viewpoint has some validity, but nevertheless the comparison involves some important differences. First, the results of analytical models, not being parameter-dependent, are by definition more generalisable. Their potential value is as a first heuristic step – they derive key relationships in a formal setting, help to form expectations about behavioural interactions and may serve as a basic input into a range of context-specific, empirical models.

Second, the black-box problem arises here also. In the case of a theoretical model used for comparative statics, the underlying assumptions are explicitly stated and embodied in the theoretical tool in a transparent way, permitting full critical scrutiny. If the model produces an unexpected result, it can most often be traced back to a particular behavioural or technical assumption, which can then be critically re-examined. The reviewer and the reader, can decide for themselves whether it is unrealistic, or whether the surprising result can in fact be considered "new knowledge". By contrast, the multi-dimensional opaque black-box nature of the large-scale numerical simulation model often makes it very difficult to do this, even for the model builders themselves. It is certainly impossible for journal reviewers and readers to assess to what extent the simulations performed by large-scale empirical models produce new knowledge rather than simply revealing the properties of the model. Indeed, this unresolved dilemma drives the ongoing dialogue between the modeller and his model. Not surprisingly, as researchers, when our model produces a result that we consider implausible, not conforming to our priors, we may well go back and tweak the model so that the results become less controversial. But of course, this also makes the results less interesting to publish. As model builders, most of us have received from editors (and as editor, I myself have sometimes written to authors) the comment: "We do not learn anything new from this exercise!"

3. Special characteristics of linked models

These considerations lead to the reflection that *linked* models may have an additional advantage in terms of publishability that is not shared by large-scale models of simple, well-understood behaviour. Sometimes the linking of several models, by the audacious coupling of processes that were until then treated as separate and non-interactive, can produce new insights – or at least new hypotheses – that are indeed worth publishing for the wider scientific community. However, the "art" resides in exploiting this potential for providing new insights.

It is useful at this point to recall the rationale for linking models. Among the benefits are that linking models (a) enables the representation of spatial variability and specificity in economic behaviour, ecological conditions, biophysical processes, institutional constraints and so on, (b) can reveal discontinuities and non-linearities implicit in the processes studied but which lie outside the range of observed data of specific components, (c) enriches the domain of the analysis by incorporating multiple, highly diverse facets of a complex reality requiring different modelling approaches[2], (d) allows the properties of the various components of the system to be simulated at their most appropriate scale, (e) extends the scope for incorporating dynamic feedback between biophysical and socio-economic processes and behaviour, as well as between linked diverse biophysical components and between spatially or temporally separated groups of economic agents, and (f) can reveal, verify and measure responses to shocks or policy changes that take effect through a long and complex series of intermediate reactions, or at several degrees of spatial separation (ANTLE and CAPALBO, 2001; VELDKAMP and VERBURG, 2004; DUMANSKI et al., 1998: LEIP et al., 2008; KIRBY et al., 2006).

Where model coupling is able to exploit one or more of these benefits, the gains can be valuable. For example, RONNEBERGER et al. (2006) report an exercise linking GTAP-EFL (a refined version of BURNIAUX and TRUONG's (2002) GTAP-E, which incorporates carbon emissions from fossil fuel combustion) with the global agricultural land-use model KLUM (Kleines Land Use Model), essentially replacing GTAP's exogenous land allocation by KLUM. They show how the results of the coupled model differ substantially for most crops and most regions from the results of either model component in stand-alone mode. ANTLE and CAPALBO (2001) show that, by linking a standard econometric production model with a land-use optimising decision model, simulated supply responses become considerably more sensitive to price changes. In each case, linking the models not only improves the quality of the prediction, but also reveals behavioural and interactive properties of the system that enrich economic understanding.

An example of a linked model permitting to some degree most of these advantages of coupling is described in MANGEN and BURRELL (2003), which examines various control strategies for outbreaks of classical swine fever in the Netherlands. The work for this paper involved linking two large models – an epidemiological model InterCSF (a farm-level, spatially identified, stochastic model designed to simulate disease spread and control measures using a daily time-step) and a market and trade model DUPIMA (a econometrically-estimated multi-market economic model including two-way external trade in piglets, live hogs and carcasses, with a weekly time-step), via a linking module EpiPigFlow. The results of InterCSF and DUPIMA after linkage are then fed into two additional modules to generate the costs of different disease control strategies and the corresponding welfare changes. Because InterCSF simulates disease spread from farm to farm stochastically, a large number of runs could be performed, whose results encompass the likely size-range of future epidemics, and results on costs and welfare changes could be obtained for every kind of case – very large epidemics (where "large" is defined by the user), or for the median epidemic, or for longer lasting epidemics (not necessarily the "largest" in terms of pig numbers slaughtered) and so on. This linked system generates spatially determined, time-dependent quarantine zones within which and out of which pigs cannot be moved, and simulates the market implications of various other control measures.

DUPIMA alone could not have produced results of sufficient interest to warrant publication in a top economics journal. Linking DUPIMA to InterCSF and the other modules, however, generates very rich results, and at least one initially surprising finding, under a variety of alternative policy-relevant assumptions regarding control measures adopted, decisions by the EU authorities regarding export bans on carcasses from outside quarantine areas, third-party closure of import markets and so on. It is precisely because of the value added from *linking* these models that the economic simulations become interesting enough to publish. Because InterCSF was already well documented in veterinary journals, and the other modules were sufficiently simple to be reasonably transparent, the work could just be squeezed into a journal-sized article for peer review by an economics journal.[3]

4. Closing thoughts

It is important, when writing up the simulations from linked models for a peer reviewed journal, to remember that its readers are a different audience from the typical contractors and end-users of the simulation output. This latter group, policy makers and other decision makers, usually ask for a limited range of scenarios, and often want confirmation of what they already know - by practical or political intuition. Scientific journals want analysis and discussion that is as rigorous and as transparent as possible, but also with a novel outcome or finding that suggests an addition, however small, to economic knowledge that was not already given *ex ante* - or at least the emergence of a new economic hypothesis that can be followed up in subsequent, more detailed studies. When presenting the simulation results for a scientific audience, it is worth exploiting the linking - the long causal chains and any surprising relationships that could only be revealed by linking – in order to make it clear that the whole is more than the sum of the parts. Economists will be interested in interpretations of the results in terms of the feedback loops and simultaneous interactions. It is important to choose the most economically interesting scenarios, which are not necessarily the ones commissioned by the policy makers. Even more important, any unexpected or counter-intuitive results must be explained primarily in behavioural terms, and not (or only secondarily) in terms of features of the model.

In summary, the methodology used in a linked model system is generally too voluminous and insufficiently interesting to form the basis of a peer-reviewed journal article. A technical report is a more appropriate outlet for this material; in such a report, methodology can be explained in depth together with details of model validation, sensitivity analyses and other quality controls that are typically not possible for referees of a journal article to conduct themselves. Moreover, a solution to a purely technical problem

2 For example, as obtained by the coupling of an agent-based model, a biophysical model, a market model, and an international trade component.

3 MANGEN et al. (2004) reports more results from the linked system.

embedded in a particular model or at the interface between two models, however ingenious it is or however costly it was to obtain, will usually not be of interest to an applied economics journal, although it may find a home in a more specialised type of journal. So what is left to sell to an economics journal? It is the economic rationale, interpretation and implications of the simulation results that should be given prominence, and it is important that they should be selected and elaborated in order to produce some economic insight that makes a genuine contribution to the literature. In fact, these criteria apply generally to most economics articles, and referees and editors of economics journals will ultimately assess the modeller's output according to the same criteria. The huge input of skilled data management and technical expertise needed to construct a suite of linked empirical models remains, in spite of its demanding nature, a means to an end and not the end itself.

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