

# T11P01 / Agent-Based Models in Public Policy Research: Perspectives and Issues

**Topic :** T11 / METHODOLOGIES

**Chair :** Alberto Asquer (School of Oriental and African Studies, University of London)

**Second Chair :** Inna Krachkovskaya (SOAS University of London)

## GENERAL OBJECTIVES, RESEARCH QUESTIONS AND SCIENTIFIC RELEVANCE

Since Shelling's 'segregation model' in the early 1970s, the use of a computational approach to simulate the interactions between a number of agents gained attention in many social science areas. Bordering contemporaneous developments in game theory, the emergence of agent-based models (ABMs) opened up novel theoretical and methodological perspectives to the understanding of various social processes. The approach gained steam in the following decades, when opportunities arose from increased computational power that became conveniently available. The launch of specialised venues like the Journal for Artificial Societies and Simulation and of resources like Leigh Tesfatsion's web site.

Yet, the impact of ABM on social science research – from economics to sociology to public policy – has been relatively modest so far. Within public policy, some ABM studies have been made in such areas as, for example, land use (Matthews et al 2007), urban planning (Ligmann-Zielinska and Jankowski 2007), income tax evasion (Bloomquist 2006), financial regulation (Krachkovskaya and Asquer 2015), terrorism (Elliot and Kiel 2004), and transport (Maggi and Vallino 2016). By and large, however, the ABM approach has not really delivered any significant advance in theorising the policy process, and its impact on policy advice and practice has been similarly rather modest.

This panel aims to address the question of how ABMs can help advance public policy research and theory. The panel will welcome papers that:

- a) Provide a review and critical appraisal of ABMs in public policy research and theory;
- b) Use ABMs in original public policy research;
- c) Discuss theoretical and methodological issues for advancing the use of ABMs in public policy research;
- d) Discuss the use of ABMs in policy advice and practice.

Papers may be either theoretical or empirical. Theoretical papers may discuss the limitations and weaknesses of ABMs, and the reasons why the ABM approach has not been strongly related to public policy frameworks and scholarly traditions so far. Empirical papers may present original studies that use ABMs for analysing public policy issues and/or producing policy advice or evaluations.

References:

Krachkovskaya, I., & Asquer, A. (2015). Do Central Counterparts Improve the Stability of Derivatives Market? Some Evidence from an Agent-Based Model. CeFiMS Research Paper DP136 (<https://www.cefims.ac.uk/research/>).

Bloomquist, K. M. (2006). A comparison of agent-based models of income tax evasion. *Social Science Computer Review*, 24(4), 411-425.

Elliott, E., & Kiel, L. D. (2004). A complex systems approach for developing public policy toward terrorism: an agent-based approach. *Chaos, Solitons & Fractals*, 20(1), 63-68.

Ligmann-Zielinska, A., & Jankowski, P. (2007). Agent-based models as laboratories for spatially explicit planning policies. *Environment and Planning B: Planning and Design*, 34(2), 316-335.

Maggi, E., & Vallino, E. (2016). Understanding urban mobility and the impact of public policies: The role of the agent-based models. *Research in Transportation Economics*, 55, 50-59.

Matthews, R. B., Gilbert, N. G., Roach, A., Polhill, J. G., & Gotts, N. M. (2007). Agent-based land-use models: a review of applications. *Landscape Ecology*, 22(10), 1447-1459.

## CALL FOR PAPERS

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## Session 1 Agent-Based Models in Public Policy Research: Perspectives and Issues

Thursday, June 27th 08:00 to 10:00 (MB 2.255 )

### Discussants

Alberto Asquer (School of Oriental and African Studies, University of London)

Inna Krachkovskaya (SOAS University of London)

### Simulating policy process theories with agent based modelling

Klein Raphael (EPFL)

This paper provides a practical approach to the modelling and simulation of the policy process within an agent-based simulation framework. The policy process model is built using concepts from the policy cycle, the multiple streams and the advocacy coalitions frameworks.

The approach selected uses the model as an add-on to traditional “technical models” that represent a wide range of policy domains – from renewable energy to urban segregation to name a few. The policy process model feeds the technical model policy instruments selected by agents active in the policy arena based on the insights and structure of policy process theories. The technical model then informs agents within the policy process of its current state, further propelling the policy process model and the possible selection and implementation of policy instruments.

The aim of simulating the policy process is to understand the feedback effects occurring between the policy process and its associated technical system, and the emerging policy evolution over time. Beyond the specific domain related questions, the model can also be used for a wide array of studies internal to the field of policy process studies, such as the evolution of the agents’ beliefs or policy learning, the evolution of the policy network or the influence of agent interactions for the selection of an agenda or policy instrument.

The policy process model is based on a two steps approach where first an agenda is created by the agents within the policy subsystem. This is followed by a policy formulation step where the same agents select a policy instrument that would best fit their respective goals and decide whether to implement that said instrument. Four agent-types are considered for the decision making process: policy entrepreneurs who push for their own interests, policy makers which have decision making power, external parties (media, NGOs, ...) which inform other agents of the states of the world and the electorate which influence the policy makers’ goals.

The simulation of the policy process can help the field in several different manners. First, gaps in the policy process theories were identified and subsequently addressed in the implementation of the operational model. This allows theorists to cast a critical look and in some cases improve these theories through empirical observations. Second, the use of agent-based modelling and simulation of policy process helps push theories that are generally used to study cases ex post, to explore what could happen in a specific set of actors system and policy environment. Third, this approach could be used in the future with a range of empirical cases to provide more informed policy advice to key stakeholders.

### Fisheries policy and invasive seaweeds: An agent-based model for policy research

Ofori Roland (Michigan Technological University)

Knowledge of the long-term impacts of invasive seaweeds on fisheries is essential to the development of

sustainable fisheries policies. This is especially true in countries where fish stocks are severely overfished and fisheries are poorly managed either due to a lack of sustainable fishing policies or inadequate enforcement of such policies. The beaching of invasive *Sargassum* seaweeds in West Africa and the Caribbean since 2011 presents threats to, and opportunities for, poorly managed fisheries.

On the one hand, free-floating seaweeds on the sea and piles of decaying seaweeds on the beach have caused a reduction in fish catch and loss of fishing jobs (Ackah-Baidoo 2013; Addico and deGraft-Johnson 2016). On the other hand, the influx of invasive seaweeds has served as a natural mechanism to regulate and rebuild collapsing fisheries by reducing fish catch. Hence, although seaweed cleanup may turn out to be the preferred policy choice to reduce the negative impacts of invasive seaweeds on the economic (fish catch) and social (distributional impacts) sustainability of fisheries, it may not be a sustainable policy choice in the long-run as the opportunity to enhance environmental (fish stock) sustainability will be lost. To manage invasive seaweeds with an objective to enhance fisheries sustainability, we need to understand how invasive seaweeds impact the sustainability of poorly managed fisheries in the long-run. Unfortunately, the environmental policy and fisheries policy literatures provide no knowledge in this regard.

To enable a comprehensive study of the temporal and spatial dynamics of the impacts of seaweed invasion on fisheries, we need to adopt a complex systems approach and use Agent-based modeling (ABM). A fishery can be characterized as a complex system comprising of interacting and autonomous units of different fish populations and heterogeneous fishing groups, and a set of management policies and social conditions that influence the interaction between fish populations and fishing groups. ABMs are the most capable computational models that can allow us study the impacts of invasive seaweeds on a fishery as a complex system. Although several ABMs have been developed to study the sustainability of fisheries (Soulie and Thebaud 2006; Elliston and Cao 2006; Cabral et al. 2010; Gao and Hailu 2011; Gao and Hailu 2013; Kjelland et al. 2015; Libre et al. 2015; Little et al. 2009; Cooper and Jarre 2017; Cenek and Franklin 2017; Gutierrez et al 2017), none of the existing models are capable of studying the impacts of invasive seaweeds on fisheries.

To address the gaps outlined above, we have developed an ABM of marine fisheries with open access regime. Using Ghana as our case study, we will evaluate the temporal and spatial dynamics of the impacts of invasive seaweeds on the sustainability of marine fisheries and the trade-offs between different levels of seaweed cleanup policies in the long-term.

## **Blue Carbon Ecosystem Conservation in the Philippines: Understanding the Behavior and Interactions of Agents Under Alternative Policy Scenarios**

Rizalino Cruz (National College of Public Administration and Governance, University of the Philippines)

The paper applies agent-based modeling (ABM) to examine collective action among stakeholders involved in preserving marine and coastal resources in the Philippines, which are suffering from anthropogenic environmental degradation. The ecosystem services of seagrass beds and mangrove forests have been severely hampered by illegal fishing, aquaculture, mangrove exploitation, urban coastal development, and land use change. These blue carbon ecosystems are facing the risk of destruction, which increases the vulnerability of coastal communities to natural disasters and food security issues.

The study raises the following questions: Which agents are involved in blue carbon ecosystems? How do these agents behave and interact in their environment? And how does the system react under alternative policy scenarios? It uses institutional theory and agent-based modeling to answer these questions. It examines the formal and informal rules governing the behavior of agents in blue carbon ecosystem conservation and how these agents register their preferences and respond to actions of other agents, the changes in the environment, and the institutional arrangements adopted.

The Batan estuary in Aklan province located in the Panay Island of the Philippines is used as case study. The estuary is managed by several municipalities and is home to a large coastal community, which is dependent on fishing as means of livelihood. The community has been witnessed to environmental degradation due to the conversion of mangroves to fishponds, use of illegal forms of fishing, pollution from chemical use in aquaculture ponds and agricultural farms, and siltation in rivers and lagoons.

The paper details the methodologies applied to formulate the Overview, Design Concepts, and Details (ODD) Protocol and the Unified Modeling Language (UML) diagrams that are implemented in the NetLogo platform. These methodologies include the conduct of policy consultations, key informant interviews, and workshops. The study discusses the findings and their implications for policies as well as the relevance and limitations of ABM as a tool for ex-ante policy analysis.

## **Exploring Civil Service Bargain Regimes: An Agent-Based Model of the Relationship between Elected Public Officers and Public Managers**

Alberto Asquer (School of Oriental and African Studies, University of London)

Inna Krachkovskaya (SOAS University of London)

The relationship between elected public officers and public managers within the civil service bargain (CSB) has been subjected to intense scholarly inquiry from both the public policy and public management perspectives. Public policy research has especially considered the role of public managers within the implementation stage of the policy cycle (Ricciuti et al., 2004). A key issue, in this respect, is whether public managers behave consistently with the policy mandate or they deviate by re-interpreting policies that they may partially disagree with (Tummers et al., 2012). From the public management perspective, a key issue is whether public managers should be entrusted with enough discretion so that they can contribute defining what public value is or they should be held strictly accountable for the attainment of specified policy goals and targets.

The relationship between elected public officers and public managers is affected by the institutional conditions where they operate. For example, features of the spoils system and of the incentive structure to attain policy targets are important to account for appointment of public managers (Lapiente and Nistotskaya, 2009) and organizational cheating (Meier et al., 2006). Explanations that focus on the role of the institutional context, however, tend to paper over the role of agency and social interaction. Elected public officers may pursue covert agendas but the attainment of public objectives, possibly in relation to the desired distributional effects of partisan policies. Public managers may possess more detailed knowledge about the effects of policy interventions with respect to elected public officers. Both kinds of actors, moreover, interact with each other when especially they take qualities of other actors into account in their policy decisions.

Does the interaction between elected public officers and public managers result in stable patterns or in erratic trajectories? This study aims to investigate the process dynamic and effects of the relationship between these two kinds of actors by using a simulated agent-based modeling approach. Building on assumptions about the hierarchical relationship between elected public officers and public managers, we model a two-stage budget allocation among policy programs and, within a given program, specific actions. We explore the role of parameters such as actors' information about the performance effects of budget allocation choices, citizens' inclination to vote depending on the performance of implemented public programs, and elected public officers' inclination to appoint public managers in relation to their skills to direct funds to effective policy actions and to their loyalty to the policy orientation of the executive. The results of the model allow drawing some tentative inferences about general traits of the CSB including actors' choices in the appointment of public managers, budgetary allocations, and the formation of collaborative or conflicting ties between elected public officers and public managers.