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INEQUALITY, FAMINE, AND COUNTER-MEASURES: TEACHING AGENT-BASED SIMULATION AS A SOCIAL ANALYSIS METHOD

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ABSTRACT

This paper reports on agent-based simulation as a social analysis method. It describes the goals, scenario, tasks, and the modeling procedure of a teaching example for understanding effects of inequality in the context of the Irish famine of 1845–52. Furthermore, it outlines further research questions resulting from the authors' experiences with teaching modeling and simulation for social analysis.

1 AGENT-BASED SIMULATION OF INEQUALITY AND FAMINE

Economic inequality is a driving force behind social strife, radicalization, hunger, famine, and migration (Grusky and Kanbur 2006). It is true that the *invisible hand* of classical economics balances out supply, demand, and prices in an ideal market. However, unequal wealth and resource scarcity lead to imbalanced markets where the poor cannot acquire goods when there are still buyers who can pay the market price.

During the Irish famine in 1845–52, crop failures were aggravated by a poorly developed inland food market. Several farmers rather exported their scarce products than selling them at low prices (Tóibín and Ferriter 2001). This effect is typical for highly lopsided markets. There is still a controversial debate to what extent liberal economic policy contributed to starvation and mass emigration, which raises two questions for analysis and teaching: 1) How can the complex interplays of markets and the effects of inequality be understood? 2) How could the effects have been countered and what can be done in similar situations? Addressing these questions, we report a case study of teaching agent-based modeling and simulation (ABM) for social analysis of the Irish famine. Agent-based models represent individuals as software agents, focusing on causation and interactions between agents, which makes them suitable for analyzing complex market dynamics in different scenarios (e.g., by introducing hypothetical counter-measures like food export bans). Such models can be applied in teaching for simulations and serious games to help understand economic inequality. Real world data and economic theory determine a model's components. Then, simulation explores its dynamics for deriving plausible explanations about the real world.

2 TEACHING AGENT-BASED SIMULATION FOR SOCIAL ANALYSIS

In 2017 and 2018, lectures on ABM were held at Trier University where the Irish famine provided an example scenario for inequality in markets. Groups of students had the task to model the famine and evaluate possible counter-measures against inequality in a project following Law (2008) as shown in Figure 1.

1) Questions & Hypotheses. Every ABM project starts with a research question and hypotheses. Hypotheses describe an expected relation between input and output variables of a model (Lorig et al. 2017). In the teaching example, this included (a) hypotheses about how to represent the historical situation suitably accurate and (b) assumptions about effects of market regulation (i.e., counter-measures).

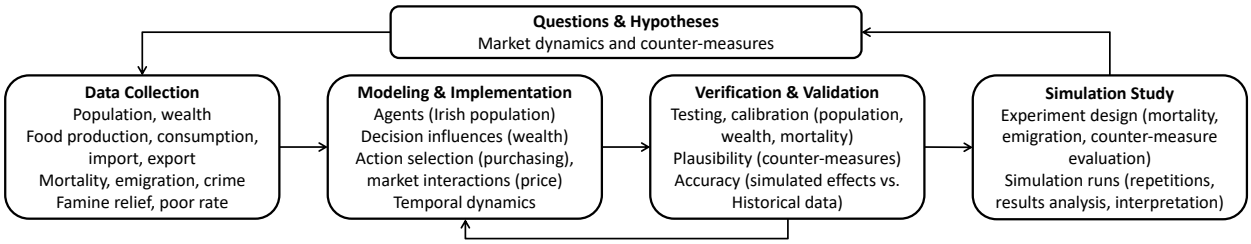

Figure 1: Modeling and simulating the Irish famine for teaching agent-based social analysis.

2) Data Collection. The data for conceptualizing and calibrating the ABM was taken from Tóibín and Ferriter (2001). It covers demographics (population and land distribution), economics (food demand and supply), famine effects (crime, mortality and emigration), and relief measures in the historical situation.

3) Modeling & Implementation. A conceptual model defines agent properties, activity options, the factors influencing activities, as well as action selection and interactions. It included the Irish population as agents, their production and consumption, migration and mortality, income and wealth, and interactions resulting in market dynamics which feed back into income and wealth. The implementations used NetLogo.

4) Verification & Validation. Plausible agent-based models require verification and validation. This covered code testing, evaluating the plausibility of counter-measures, and calibrating parameters such that simulation results match the historical data (Step 2) by setting population size and wealth and determining the impact of food availability on mortality and emigration. If necessary, a model was modified (Step 3).

5) Simulation Study. Finally, the implicit effects of market dynamics and inequality were analyzed in a simulation study. This included designing experiments in which impacts of counter-measures could be assessed. Statistical aggregation of outputs and their interpretation were required to evaluate the simulation results with respect to the initial hypotheses (Step 1) (Lorig et al. 2017).

3 LESSONS LEARNED

While the students were successful in their modeling efforts, several problems could be observed: 1) Even a small number of mechanisms and interplays becomes overwhelming. Thus, most groups modeled simple causal relationships without accounting for the scenario's economic complexity. 2) This bears the risk of tautological explanations. The strength of ABM lies in the ability to represent implicit causation. A model of direct causality only confirms what is expectable in the first place.

To overcome these problems, modelers must focus on the complexity of the application instead of the model implementation. This requires a thorough understanding of the mechanisms to be represented, a rigorous procedure, and assistance of that process. Then, ABM can be applied to social analysis ranging from inequality, over social discrimination, to opinion dynamics and radicalization (Berndt et al. 2017).

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