

Review of: "Towards a model-based approach: applications to historical demography and palaeodemography"

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Potential competing interests: No potential competing interests to declare.

The Review of the

"Towards a Model-Based Approach: Applications to Historical Demography and Palaeodemography"

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The abstract emphasizes the importance of models as representations of the world, pointing to specific trends and accuracy. It allows for the examination of models in the context of historical demography and for a deeper philosophical approach to interpretation in this area. If the respected author clearly states the research question, methodology and conclusions, it will improve this format of his academic writing. Typically, the author uses C.A.R.S. Swales (1990) model. The promise of the article includes a presentation of historical examples, a discussion of agent-based models, and the argument that a deeper philosophical approach can enable explanatory treatment of populations, demography and society on a truly scientific basis in the field of science. It recognizes that information is scarce for past population and demographic studies, making modeling an important tool for reconstructing lost data and understanding historical models. The basic concept of "relationship of similarity" is introduced in the article, emphasizing that in social sciences and other scientific activities, facts are derived from a formal structure that generates explanations within its own boundaries, rather than empirical "laws."

The opening sections provide a clear and engaging introduction to the subject of the article, setting the scene for a comprehensive modeling within and beyond the historical demography context while also elaborate on the key concepts that the respected author will explore in the sections that follow.

The respected author continues the historical development of models in demographic and population data, with examples of Euler being the first researcher in 1760 to use a cross-sectional approach focusing on the population of the human race so used, Lotka in 1939 worked on Malthusian population constants over mortality and age constant time; Bourgeois-Pichat's work in 1994, focusing on a population known as a seemingly stationary population, migration and migrants of a certain age models if their age distribution is constant which, complicating matters, establish fundamental links between age structure, mortality, birth, and migration does not account for economics, religion, politics, etc.

Finally, the respected author shows the shift to more recent approaches, such as the agent-based model introduced in 2003 by Francisco Bilari and Alexia Prskavetz in, to more complex models, a shift from theoretical ideas to modeling based on simulation. The central goal of understanding how the behavior of complex biological and social systems emerges from the properties of individual objects in these systems is that this approach is primarily characterized as a bottom-up approach; instead, individual behavioral rules can define macro-spectator regularities and macro phenomena.

According to the author, agent-based models derived from simulation analysis by mathematicians and physicists have seen wide adoption across disciplines. The respected author describes the origin, history of agent-based models the development of these models, their generality and their basic principles

The respected author provides insights into agent-based models, their multidisciplinary nature, and their usefulness in historical and demographic contexts. This highlights the advantages and limitations of this approach and points to the need for further discussion of the role of individual behavior in explaining larger models. The respected author outlines the transition from rational to empirical models, explores theories of processes, and describes the ways in which technical explanations are presented In this view, theories describe empirical reality types by deducing the formal structure created by researchers on the phenomenon being studied. The aim is to show how a logical structure and real-world context meet. However, applying isomorphism in the social sciences is challenging because real populations do not live in standardized settings as they do in the natural sciences. This poses challenges in analyzing relationships between complex simulation models and empirical data, and raises questions about how to determine and demonstrate isomorphism and symmetry, and validate simulation models. The article highlights the problem that correct predictions can come from models with dimensions and emphasizing the consequences of misinformation, the problem that correct predictions can result from a model with incorrect assumptions and inputs.

To address these challenges, the respected author proposes a mechanistic and technical approach, which leads to new or redefined concepts. This method uses induction to discover the theory of a phenomenon from learning its properties, thus returning it to its previous understanding. By induction this article aims to find theoretical implications, which involves identifying the combination of concepts necessary for the observed properties of a phenomenon to be conceivable or possible.

The article introduces the concept of a system, which is a formal (conceptual) model that represents the characteristics of a social system and the social system itself, which is the objective of the formal model.

The formal model's description is as described below:

- Start by the systematic observation of certain properties of a social system.
- Infer the formal (conceptual) structure implied by these properties.
- The formal structure guides the study of the social mechanism responsible for generating the observed properties.
- The mechanism either confirms the advanced formal structure or indicates the need for revision.

A mechanistic approach allows the construction of a formal framework that represents the conceptual framework of the phenomenon under study. At the same time, it considers the social factors that contribute to this phenomenon.

The article argues that this approach has been used successfully for the study of probability, a critical tool in demography. It draws a parallel between the development of probability theory from Pascal's conception in 1654 to Kolmogorov's formal axiomatization in 1933 and the evolution of demography from Graunt's conception in 1662 to Euler's proto-axiomatization in 1760. The mechanistic approach, as proposed by Franck, offers a systematic way to give mechanistic explanations in the social sciences.

The conclusion emphasizes the importance of a model-based approach in populations and demography, which can lead to a deeper understanding of population dynamics and the ability to define functional processes and causal population relationships. It also encourages young researchers to undertake this important work. In the final section, the author

reflects on the historical models of demographic data and emphasizes the value of a model-based approach. Here are the main points to conclude:

1. **Historical paradigms:** The respected author highlights four paradigms that have shaped history of demography: cross-sectional, longitudinal, event history, and multilevel. These models have evolved over time, each offering a new perspective on populations. Importantly, each model builds on and complements the previous model, extending the understanding of population dynamics.
2. **Model-based approach:** The model-based approach is presented as a way to increase the value provided by four historical paradigms. This allows us to have long-range interaction and correlations across demography structures. In addition, it enables researchers to generate "what-if" scenarios by analyzing simulation parameters, based on a functional-mechanistic approach. Recurrent Bayesian networks are cited as an example of mechanism-based modeling, especially for cancer research.
3. **Challenges and opportunities:** The conclusion acknowledges that although model-based theories have been applied to cancer research, that demographic-level mechanistic understanding is not yet available. However, the respected author hopes that the model-based framework will pave the way for more accurately modeling the social processes underlying population and demographic structures. The young researchers are encouraged to undertake this fundamental task. Finally, appreciating the article's thorough and thoughtful perspectives, discussions, proposition and suggestion, and while the article provides a valuable overview of model-based approaches in demography, it can enhance its overall quality by stating and addressing certain limitations:

1. **Few citations of recent research:** Article focuses on some older areas, and lacks citations of recent research or developments in population data. Updated references with recent studies including will make the story more relevant.
2. **Repetition:** Throughout the story, certain ideas and points are repeated over and over again, leading to a lot of rework. Simplifying the content and avoiding unnecessary repetition will improve clarity and conciseness.
3. **Incomplete evaluation of alternatives:** The article focuses primarily on the utility of a model-based approach in demography and population data. Although this is a valid approach, it can be strengthened by providing a balanced discussion that also considers potential shortcomings or limitations of this approach, such as data requirements and model complexity.
4. **Limited discussion of criticisms:** The article briefly discusses the challenges of agent-based models but does not delve into a detailed discussion of the criticisms and limitations associated with various modeling approaches in demography. A more critical analysis of these issues will give us a more rounded perspective.

On the other hand the outstanding and superior strong points of the article, as it follows, contribute to the article's value as a resource for researchers and scholars interested in demography and modeling:

Comprehensive Overview: The article offers a comprehensive overview of the history and evolution of modeling in demography. It traces the development of modeling approaches from the past to the present, providing readers with a rich historical context.

Emphasis on Model-Based Approach: It emphasizes the importance of a model-based approach in demography, highlighting the significance of formal structures and conceptual models for understanding demographic phenomena.

Integration of Different Paradigms: The article integrates various paradigms in demography, such as cross-sectional,

longitudinal, event history, and multilevel approaches. It demonstrates how the model-based approach can build upon and enhance these paradigms, rather than replacing them.

Discussion of Agent-Based Models: The article delves into agent-based models and their use in demography, showcasing their potential for understanding complex social processes and historical demography.

Philosophical Considerations: It introduces a philosophical perspective on the challenges of explaining demographic phenomena and emphasizes the need for mechanistic models and causal relations.

Encouragement for Future Research: The article encourages young researchers to explore model-based approaches and the development of mechanistic models in demography. It sets a research agenda for the field, inspiring further investigation.

Clear Articulation of Ideas: Despite its technical content, the article effectively articulates complex ideas and concepts, making it accessible to readers with a background in demography or related fields.

Citation of Influential Works: The author references significant works in demography, statistics, and social sciences, demonstrating a well-researched understanding of the subject matter.

Forward-Looking Perspective: The article ends on a forward-looking note, suggesting that model-based approaches can lead to a better understanding of the social mechanisms underlying demographic structures.