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BIJAK J. (ed.), 2022, *Towards Bayesian Model-Based Demography: Agency, Complexity and Uncertainty in Migration Studies*, Springer Nature Switzerland, 263 pages.

In this volume, Jakub Bijak, along with nine researchers from the universities of Southampton and Rostock, attempts to move beyond the essentially descriptive approach too often chosen in demography, proposing instead an explanatory approach based on modelling. The authors' general method can be applied to any study of human populations, but here they provide a detailed application to the modelling of the 'migration crisis' that followed the Arab Spring and the Syrian Civil War. Between 2011 and 2019, thousands of refugees, mostly from Syria, Iraq and Afghanistan, sought to reach Europe by various direct or circuitous routes. That 'migration crisis', a more recent version of which has seen Ukrainians migrating in their millions into other European countries, demonstrates the interest of this type of analysis in this context, and more generally. However, while the reason for the Ukrainians' exodus is the same – flight from war – their reception in the European Union has taken a completely different set of paths.

The phenomenon is a complex one. As the authors explain, the migrants of 2011–2019 took various 'routes' depending on the information they gathered along the way, which the authors term 'rumours'. Their 'Routes and Rumours' models are based on a series of arguments.

The first supports the use of a Bayesian approach. Until recently, demographers very often reasoned in terms of a frequentist, or objectivist, approach to statistics: as the number of experiments tends towards infinity, the probability of an event can be perfectly estimated. This approach was criticized as early as the 18th century by Bayes⁽¹⁾ and Laplace,⁽²⁾ who believed that probability is not independent of the individual who is measuring it, and that any new information about an observed phenomenon helps the measurer to improve his a priori opinion by using Bayes' theorem to calculate an a posteriori probability. Due to the complexity of the calculations involved, this approach cannot really be applied without the aid of computers. But the desire for an objective demography has also played an important role in the rejection of subjective approaches to probability.

The alternative approach taken by the authors is built on the Bayesian paradigm, which they apply to projection, to producing estimates for sparsely populated areas, and to solving highly complex, structured problems. This is the type of approach taken by Jakub Bijak⁽³⁾ from 2011 to predict future international migration, offering a necessary tool to model this 'migration crisis'. Here, it provides a means to produce an increasingly faithful approximation of the reality of these migration phenomena, using models that move progressively closer to the migrants' actual situation. At the same time, the authors clearly recognize

(1) Bayes T. R., 1763, An essay towards solving a problem in the doctrine of chances, *Philosophical Transactions of the Royal Society of London*, 53, 370–418.

(2) Laplace P. S., 1778, Mémoire sur les probabilités, *Mémoires de l'Académie Royale des sciences de Paris*, 1781, 227–332.

(3) Bijak J., 2011, *Forecasting international migration in Europe: A Bayesian view*, Dordrecht, Springer.

the limitations of an approach built on their choice of a class of Bayesian models that they themselves have defined in advance.

The second line of argument concerns the use of a model-based approach – recently recommended by Tom Burch⁽⁴⁾ and Courgeau et al.⁽⁵⁾ – which, as mentioned above, aims to move demography beyond the realm of the purely descriptive. The particular approach proposed here involves agent-based models of migration. These models simulate the movements of individuals, which can then be calibrated to explain patterns observed at the macroscopic level.

The authors use these models to factor in the principal aspects of this ‘migration crisis’, whether demographic, political, psychological or economic, setting aside others that they consider marginal.

Their ‘Routes and Rumours’ model is developed in the second part of the book, consisting of nearly half of the chapters. This model uses the computer-simulated representation of individual behaviours, through the application of behavioural rules at the micro level, to study emerging effects at the macro level (p. 21). Numerous demographers have adopted approaches of this type in the 21st century, motivated by the flexibility they allow in describing the mechanisms and assumptions underlying the model in terms of individual behaviours. The authors point out, however, that this model has the disadvantage of using arbitrary assumptions that are difficult to specify (p. 37): while a given hypothesis generates a given effect, many others can also do so, and it can be impossible to determine which is the correct one.⁽⁶⁾

In the third part of the book, the authors recognize that their ‘Routes and Rumours’ model is insufficient on its own to explain this migration crisis, and propose a further ‘Risk and Rumours’ model (Chapter 8). This model adds new information on the process under study, and in particular on the risk of death, thereby increasing the model’s explanatory power. Can this model be considered a fully inductive one,⁽⁷⁾ in Bacon’s⁽⁸⁾ sense of this term? The authors give a clear answer to this question (p. 153): ‘some elements of this approach cannot be seen as a purely inductive way of making scientific advances...’ This by no means detracts from the innovative nature of this volume, whose novel Bayesian

(4) Burch T., 2018, *Model-based demography: Essays on integrating data, technique, and theory*, Dordrecht, Springer.

(5) Courgeau D., Bijak J., Franck R., Silverman E., 2017, Model-based demography: Towards a research agenda, in Grow A., Van Bavel J. (eds.), *Agent-based modelling in population studies*, Switzerland, Springer International Publishing.

(6) Conte R., Gilbert N., Bonelli G., Cioffi-Revilla C., Deffuant G. et al., 2012, Manifesto of computational social science, *European Physical Journal Special Topics*, 214, 325–346.

(7) The concept of induction proposed by Bacon is often confused with the notion of empirical induction later proposed by Hume (1748, *Philosophical essays concerning human understanding*, London, A. Millar). Although Hume did not use this term at the time, later philosophers of science have often used it in discussing his work. For more details on these fundamental differences, see Franck (2015, *Faut-il se défaire des connaissances vulgaires dans la recherche?* in Walliser B., *La distinction des savoirs*, Éditions de l'EHESS, 295–309).

(8) Bacon F., 1620, *Novum organum*, London, J. Bill.

demographic approach provides the tools for an increasingly in-depth exploration of the migration crisis.

Later in Part III, Toby Prike's Chapter 10 presents an interesting perspective on the replicability of human phenomena, particularly in psychology. Examinations of objectivist statistical methods for interpreting the validity of particular inferences, such as the confidence intervals associated with an estimate, have revealed that they can often be unreliable. This led to a 'replication crisis', which began in psychology in 2011 with an article by Daryl J. Bem,⁽⁹⁾ who showed that these methods could be used to justify belief in paranormal phenomena. Over the following years, the crisis spread to the other social sciences. Many researchers have tried and failed to replicate the results of earlier studies, often obtained from a small sample, even where the original presented apparently conclusive confidence intervals. This pattern highlights the dangers of using objective probability to interpret statistical inferences. Most scientific journals now reject altogether the use of the phrase 'statistically significant' in this objective sense.

This methodological volume is essential reading for researchers not only in demography but across the social sciences. It presents detailed results on the migration crisis created by the Syrian Civil War, but also highlights the generality of its methods, which should be extended to the study of many other phenomena, such as the current Ukrainian exodus. Very little modelling work at this level of detail has been published to date; this undertaking is both a necessary and an extremely difficult one.

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(9) Bem D. J., 2011, Feeling the future: Experimental evidence for anomalous retroactive influences on cognition and affect, *Journal of Personality and Social Psychology*, 100(3), 407–425.