Mary S. Morgan, *The World in the Model*. How Economists Work and Think, Cambridge, Cambridge University Press, 2012, 442 pp., £31, ISBN 9780521176194

Mary S. Morgan is Albert O. Hirschman Professor of History and Philosophy of Economics at the London School of Economics. She published groundbreaking analyses in the history of econometrics, in the methodology of economic models, and in the recent history of economic thought more broadly. *The World in the Model*, published in 2012, is the culmination of more than a decade of reflection on *how economists work and think* using small manipulable objects. The book won Morgan the best book award from the European Society for the History of Economic Thought in 2013. Surprisingly, the book had never been reviewed in this journal. Perhaps this omission reflects a feeling among members of the history of economic thought community that the book belongs solely to the methodology of economic literature. Ironically, it has received harsh criticisms from that community (with the exceptions of Sugden, 2013, and Angner, 2015), and I believe it deserves greater attention from historians of economics.

Morgan writes a history of models as a specific class of 'scientific objects', to use Daston's (2000) expression. Models are useful because they apprehend types of phenomena. Their typical nature allows models to assume the function of mediators between theory and data (Morgan and Morrison, 1999), or to provide « intermediate services » to economists, as Morgan and Grüne-Yanoff (2013) later argued.

Morgan adopts a pragmatic approach and focuses on what is it that economists do with models. She argues economists enquire within their small model worlds and also use them to enquire about the bigger world. Reasoning with models generally involves first building a model to answer a question or a puzzle about the economic world. Economists then question their model and derive answers using the resources internal to the model. Finally, they tell a story that links the demonstration in the model to the outside world. Identifying the role played by narrative is one of the most original contributions of Morgan's book to the understanding of economics. Narratives configure the elements of the model and allow the economists to assess the relevance of the formal results derived in the model to the broader problems of the economic world (p. 225 ff.). However, there is no universal logic to make inferences from the world in the model to the world outside. Narratives help economists to draw casual inferences from the model to the world. Even in comparison with inferences made from a laboratory setting to the world, inferences from models suffer from a stronger problem of external validity because the model world is composed of different entities than the outside world (p. 287).

The greatest strength of the book is to demonstrate the diversity of modelling practices in economics: graphs, a system of water pipes and tanks, a set of equations, etc. Morgan's approach to models as a historically situated scientific practice has been praised by Halsmayer (2014) and Dogamova (2015). For Morgan, many different objects can be considered models, but they are always purpose-built and manipulable. Rejecting grand historical narratives and general philosophical theories of science, she refrains from providing a universal definition of models in economics—to the disappointment of philosophers (see, for e.g., Claveau, 2015). In fact, Morgan argues that the proper epistemological point to study models is historical: "The history of science is usually messier

than philosophers would like it to be […] It's not that ideas from philosophy of science are not relevant […] The point is rather that clean-limbed philosophical analysis does not so much organise our sprawling historical experience as stumble over it." (p. 158). Each model, Morgan argues, has to be understood within the economic intellectual tradition in which it is embedded.

The book is composed of a series of case studies of models ranging from the early nineteenth century to the second half of the twentieth which are held together by philosophical remarks on the nature of models. The case-by-case approach is fully justified by the fact that models are built for specific purposes. Some of Morgan's historical cases are better elaborated than others. Ricardo's "model farm" is an outstanding case of the pre-history of economic modelling—an age when models were not yet the "natural" way of doing political economy. Morgan paints an image of Ricardo far from the abstract deductivist common view. Ricardo was also a practical man, a landlord interested in the real farming experiments of his day. Reasoning with the available data, he devised numerical examples to demonstrate his laws of distribution.

The third chapter tells the story of the Edgeworth box, the famous small-scale, manipulable diagrammatic instrument built to enquire about the effect of trading on the respective welfare of two individuals. The imaginative diagram drawn by Edgeworth was transformed into a box with a double system of inverted axes by Pareto. Some of the concepts invented for this « box » such as indifference curves, contract curve, optimal point, later travelled to other models and came to have a life of their own in neoclassical economics. The Edgeworth box is a case where reasoning in the model is intrinsically tied to visualisation. The diagram was not an illustration, nor a translation of a previously conceived verbal argument. Nowadays when economists think about the effect of a change in the endowment of an agent on the relative trading equilibrium and respective welfare positions of traders, they often think diagrammatically. Even when not using pen and paper, they draw curves in their head, just as they do when they ask what is the effect of a shift in demand on the market price. Thus, the notorious mathematisation of economics, of which Edgeworth and Pareto were strong advocates, was fostered by the cognitive support of diagrammatic visualisation.

Morgan also unfolds the history of the Newlyn-Philips hydraulic machine. The analogical model was built by two economist friends who shared an interest in macroeconomics and an engineering problem-solving mindset, yet had complementary skills. The machine which mesmerised those who saw it working was not only a pedagogical device, it also suggested new insights on the functioning of the economy. For instance, it made clear how stocks and flows come together to determine the rate of interest, something that diagrammatic models could not show (p. 210).

The chapter dealing with the history of the prisoner's dilemma is also a must-read. Invented during the Cold War, the famous game is an exemplar case to argue that narratives are essential to making sense of a model. The identity of the game depends as much on a payoff matrix structure respecting certain inequalities, as on a narrative accompanying it (p. 349). Like most neoclassical models, the prisoners' dilemma embodies a thin economic man guided by selfish rationality.

Morgan devotes another chapter to the history of the Economic Man, and treats it as a model of the real human being that can be reasoned with just as any other economic model. Following J.S. Mill, economists have often argued that economic modelling boils down to abstracting, taking away realistic features of man to get a mechanical agent. Yet, Morgan shows that modelling is not a one-way process of subtraction, that it entails adding something new, such as perfect foresight (p. 150). This methodological point is important, but as an historical case study of one type of model—economic men—the chapter has its weaknesses. Morgan's flexible definition of models leaves the reader wondering if every big part of a model is also a model itself? One might argue that the homo œconomicus is only a component of economic models. The target system of this model man is not a social phenomenon, it is only a link in the chain. Only once the economic man is given resources to produce, consume, trade, etc. does the economic phenomenon emerge. To put it differently, the model-man is not a fully specified economic model. This chapter also suffers from a semantic imprecision. Morgan writes about J.S. Mill's homo œconomicus, but Mill never used the expression, nor that of 'economic man'. The former expression only came to prominence in the late nineteenth century works of M. Pantaleoni and V. Pareto.

The question of how models relate to the outside world receives a less thorough treatment than that of how economist enquire within their model world, as Sugden (2013), Claveau (2015), and Doganova (2015) noted in their review. Morgan stresses that economists do not have direct epistemic access to the world: models are not images of a world they already know—they are their ways of learning about it. The empirical knowledge of the world derives mostly from econometrics, a topic which is not addressed in this book, even if it one on which Morgan has written extensively in the past. As modelling became the natural way to relate to the world, economists came to see the big world as made up of their small world models. Thus Morgan adopts a peculiar metaphysical posture admitting that the connexion between the ontology of the world and the epistemology of the model is not always clear, to the despair of philosophers like Hausman (2015). Thus, Morgan's position comes close to what Daston (2000) labelled « applied metaphysics ».

What does a study of modelling practices in economics reveal in terms of the qualities models must possess to be successful? Useful models have to be manipulable. For this, they need to have sufficient economic resources (p. 237). They must also be small enough to be manageable, but complex enough to address relevant problems of the outside world. A rich model will allow for a degree of variety in the results that will surprise the economists, that will suggest new insights. What makes models fruitful working objects is their typicality—the fact that they are representative of a class of phenomena—and their ability to reveal secrets on the economic world (p. 380). These features allow the artefactual models to be carried over to new problems. This process of diffusion assumes a shared understanding of the conventions of interpretation of the model among the members of the scientific community. For instance, successful model narratives need to be consistent and plausible, but they also need to be meaningful (p. 246). Morgan recognises that "the elements in a narrative that make a model count as meaningful are contingent on local scientific knowledge: they depend on what economists of a certain time take to be a good explanation of human behaviour or of the behaviour of the whole economy; they depend on the theories and assumptions the time and place and group of economists involved." (p. 250)

To put it differently, one could argue that the success of a narrative depends on an original mix of newness and familiarity. And there seem to be no other way to evaluate the goodness of a narrative, or more generally of a model, apart from referring to the history of economists' argumentative practices. Morgan argues that narratives do not merely play a rhetorical role, they have an epistemic function: they make sense of the material to economists and they help to bridge the gap between the world in the model and the outside world (p. 239). In a recent paper, Morgan (2017) further argues that narratives have a fundamental ontological role to compose the relationships among the objects of the model. Through the narrative, economists make commitments on the nature of the entities which compose their model. Granted that, I believe the validity of narratives still hinges upon the rhetoric of economists at a given time. A narrative is successful because it blends in—while adding something new—to the previously accepted narratives in the field.

The World in the Model makes the case that modelling became the natural way of doing economics in the twentieth century, but it was not always so. Model-thinking can be retrospectively found in a few eighteenth (e.g. the Tableau économique of Quesnay) and nineteenth-century cases, but it wasn't the common style of economic reasoning. Now that models have been naturalised, economists do not notice that they are thinking in a different way from their predecessors. Models superseded general theories, just as theories had replaced the nineteenth century quest for general laws of political economy. This change of reasoning style in economics needs further investigation. One puzzle is what holds the economics discipline together in the face of the theoretical fragmentation in manifold models? Morgan maintains the discipline is united by two common assumptions in models: individual utility maximisation and the equilibrium tendency of the aggregate models (p. 394).

Morgan's story of the rise of modelling in economics highlights, however, a continuity in the way economists think. On a standard account, mathematical models replaced institutional traditions which described, analysed and categorised economic behaviours in endless typologies. Such was the case of the German economic tradition in the nineteenth century (see Lindenfeld, 1997). Yet, Morgan shows that models also derive their explanatory power from the typicality of phenomena they apprehend (p. 390). Economic knowledge is thus organised at a certain level by an assemblage of types of models. The typologies result from manipulations of the model assumptions, in the same way that variations of the parameters and controls in a lab experiment are classified as different games. This is perhaps most striking in industrial economics, a field organised by types of models which vary according to the institutional assumptions made to characterise the type of situation.

Morgan's book constitutes a substantial contribution to the history of economics and a crucial one on the practice of modelling. Nearly all chapters of the long book are adapted from papers published in journals and books in the previous years. They can be read independently of each other, although there are great benefits in going through the whole book to appraise all the evidence for the claims made in the first chapter. This book has been, since 2012, and will be, for some years, of interest to multiple audiences. Scholars in science studies will get a rich overview of economic practices in historical perspective. Economists will value the historical and methodological perspective it provides on models they commonly teach to their students. Specialised historians of economic thought will

appreciate the case studies taken from different periods. Economists should recognise their trade in the naturalised epistemology of models proposed by Morgan. As Angner (2015) put it: "it offers what may be the most careful and charitable account to date of what economists are up to in their abstract, formal work, and shows that such work serves an important epistemic function". Paradoxically, it can help reconcile anxious economists with what they do, as well as providing critics of neoclassical economics— from within and from outside the discipline—with a more accurate understanding of what it is that economists do.

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