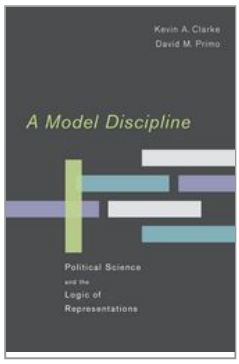

A Model Discipline: Political Science and the Logic of Representations
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Abstract and Keywords

Models have come to be the dominant feature of modern political science and can be found in every corner of the field. Despite this ubiquity, most political scientists know very little about models, their properties, or how to think about models in a rigorous fashion, all despite the fact that political scientists are highly skilled at model construction. This chapter introduces the model-based view of science that is advocated in this book. It is contrasted with the dominant way of thinking in the field: theory testing. The chapter also introduces the five main themes of the book: science is not what we think it is; current practice is not “philosophy-free”; models are objects; models are not tested with data; and theoretical models are necessary components of explanations.

Keywords: models, philosophy of science, theories

Practical economists, who believe themselves to be quite exempt from any methodological influences, are usually slaves of some defunct methodology.

—ECONOMIST KEVIN HOOVER

1.1 The Model in Political Science

This book is about how to think about models and the roles they play in our discipline. Models have come to be the dominant feature of modern political science and can be found in every corner of the field.[1] Pick up any recent issue of the top social science journals, and you will find models. Some are mathematical or formal models, and some are computational or algorithmic

models. An even greater number are empirical or statistical models, and some are verbal or nonmathematical models. Despite this ubiquity, most political scientists know very little about models, their properties, or how to think about models in a rigorous fashion, even though political scientists are highly skilled at model construction.

Our goal in this book is to provide political scientists with a coherent way of thinking about the models that pervade our discipline. The approach we take is known as the model-based or model-theoretic view, which holds that models, not theories, are the primary units of scientific interest. Models are seen as objects, thus neither true nor false, and are judged by their usefulness for a particular purpose. The standard analogy is to maps, which share many of the characteristic **(p.2)** traits of models. We develop the implications of this understanding and establish why existing practice is based on outdated and faulty ideas. Most political scientists, we suspect, will raise few objections to thinking about models in the way we suggest. That being said, we also suspect that resistance will begin when the consequences of this approach dictate jettisoning cherished pieces of our research tradition. These include the notions that theoretical models must be tested to be of value and that the ultimate goal of empirical analysis is theory testing.

Consider Baron and Ferejohn's (1989) legislative bargaining model, in which a dollar is distributed among legislators interested in maximizing their share. The game begins when a randomly chosen legislator makes a proposal to divide a fixed amount of public expenditures. In the simplest form of the game, if an offer is rejected, a new proposer is chosen, and the process continues until an agreement is reached. The Baron and Ferejohn legislature comprises n members, a recognition rule (random — every member has the same chance of being recognized to make a proposal), an amendment rule (open or closed), and a voting rule (majority). The legislature depicted in the model shares little isomorphism, structural or otherwise, with any existing legislature. There are no parties, no leadership, no disputes over social policy or even debates about the size of overall spending. The benefits are distributed only once. Despite these departures from reality, we clearly recognize the model as being that of a legislature.

Baron and Ferejohn's model cannot be considered either true or false. The model represents some features of actual legislatures and omits others. Moreover, the omissions are purposeful. In constructing the model, the authors sought in part to highlight the roles that proposal power, endogenous agenda formation, and the sequential nature of the legislative process play in the distribution of resources. To that end, the model focuses on proposal rights and amendment rules at the expense of other real-world features of legislatures. The way to think about this modeling effort is to say that Baron and Ferejohn use their model to represent actual legislatures for the purpose of understanding

bargaining in the legislative process.[2] **(p.3)** Reasonable people can disagree about whether the representation is useful—the model may be unilluminating, for example—but truth and falsity, and therefore testing, are beside the point. That being said, it is difficult for anyone to argue that the model has not been useful; it spawned a large body of literature and, according to the Social Sciences Citation Index at the time of writing, has been cited over 300 times.

Even if one accepts the misguided notion that theoretical models can be true or false, we demonstrate that the method we use to test theoretical models—derive a comparative static from a model and see if it holds in a regression-like statistical model—does not actually work. There are two reasons. First, the logic of the test prevents us from drawing interesting conclusions about the theoretical model. Second, we never test theoretical models with data; we test theoretical models with models of data. As data models share all the same characteristics of theoretical models and are often exceedingly fragile, assigning the data model to be the final arbiter of the theoretical model is untenable.

Theoretical model testing, in our view, is illogical; moveover, it is often unnecessary. Models can be useful in different ways without being tested. There are foundational models upon which others build, organizational models that collect empirical generalizations under a single framework, exploratory models that investigate putative causal mechanisms, and models that predict. With the exception of predictive models, none of the other uses require testing. Similarly, empirical models can be useful in the absence of theoretical models for measurement, characterizing a data set, and prediction. Two threads, therefore, comprise the argument: model testing is illogical, and model testing is often superfluous.

Our collective ignorance of the nature of models no doubt strikes many political scientists as unproblematic; after all, the ability of social scientists to construct models of precision and elegance is paramount. Increasingly, however, models are being used in ways that are antithetical to their nature. Ask a political scientist if her model is true or false, and she will most likely reply that her model is false. Conventional wisdom holds that all models are false. Ask the same **(p.4)** political scientist why she is testing her model, and a reply is likely to be much slower in coming. The initial response is often to make a claim such as “we are not testing the model, but what comes out of it,” or “the model is technically false, but it is a good enough approximation,” or “well, we are not really *testing* per se.” These half-formed arguments just generate additional questions and confusions. Why would we be interested in the implications of a false model? Are the implications of all models approximations? What does that mean for data analysis? If we are not testing the model, why is the deductive connection between the theoretical model and the empirical model necessary?

The true importance of these topics becomes readily apparent when we consider graduate teaching. Broadly speaking, methodology is the study of the ways in which political scientists justify their conclusions about the world (Blaug 1992). We are teaching a generation of top graduate students that there is a preferred way of making substantive claims. The method we teach, however, cannot be justified. It is based on outdated ideas and fails the test of logic; there is no evidence that its use has moved the field forward. Our goal is to help political scientists reach better justified conclusions by highlighting the use of models and by thinking carefully about what models can and cannot do for us.

1.2 METAPHORS AND ANALOGIES, FABLES AND FICTIONS

Before going any further, it will prove useful to put our conception of models into context by reviewing some of the different ways modern scholars have thought about scientific models. Central to any discussion of models is the idea of representation, and central to the idea of representation is use. The act of representing lies not in any necessary physical resemblance between a model and what it purports to represent, but in the way the model is used. Van Fraassen (2008, 23) writes, “There is no representation except in the sense that some things are used, made, or taken, to represent some things as thus or so.” Even a novel about animals can represent a political system. George Orwell’s *Animal Farm* can be read either as a fantastical story of animals **(p.5)** taking over a farm or as an allegory for the events leading to Stalinism (Godfrey-Smith 2009). Whether the novel represents Russia in the early twentieth century depends on the interaction between intention and use.

Modern treatments of scientific models go back to Black’s (1962) seminal discussion of models as metaphors. Black begins with *scale* models, by which he means three-dimensional versions of objects that have been scaled either down (as in a model ship) or up (as in a model of an atom). The objects being modeled may be real (such as the Space Shuttle Endeavour) or imagined (such as models of spaceships from movies or television shows). These kinds of models are designed to serve specific purposes that range from the pedagogical to entertainment, and depending on the use, some features of the original are important to the representation whereas others are irrelevant. A child would find a model airplane that could not fly quite dull, whereas an adult collector would not care less, provided the model sported authentic detail. Either way, the change of scale must introduce distortion, and it follows that “perfectly faithful” models do not exist. A model can represent “only by being unfaithful in *some* respect” (Black 1962, 220).[3]

Black moves toward the types of models used in political science when he writes of *analogue* models in which an object is represented in some new medium. Whereas a scale model shares features with its original, an analogue model shares only a structure or pattern of relationships. A subset of analogue models are mathematical models through which structures are represented in the new

medium of mathematics. Black (1962, 223–24) writes of the use of mathematical models in the social sciences in a way familiar to any political scientist (at least until the last sentence):

The original field is thought of as “projected” upon the abstract domain of sets, functions, and the like that is the subject matter of the correlated mathematical theory; thus social forces are said to be “modeled” by relations between mathematical entities. The “model” is conceived to be *simpler* and *more abstract* than **(p.6)** the original. Often there is a suggestion of the model’s being a kind of ethereal analogue model, as if the mathematical equations referred to an invisible mechanism whose operation illustrates or even partially explains the operation of the original social system under investigation. This last suggestion must be rejected as an illusion.

Theoretical models, according to Black (1962, 230), stand in relation to their originals in the same way that analogue models and their originals do. That is, the theoretical model represents the structure of the original. Black describes such models as metaphors with the power to bring “two separate domains into cognitive and emotional relation” by using the language of one as “a lens for seeing the other” (236–37). Like models, metaphors may fit well or not, and the outcome of metaphorical thinking is unpredictable; the metaphor may help the scientist see new connections.

An idea closely related to the view of models as metaphors is that of models as analogies, which are often important in understanding metaphors (Bailer-Jones 2009). Hesse (1966), drawing on the work of Campbell (1920), makes the models are analogies argument and illustrates her approach with an example from the dynamical theory of gases: gas molecules are analogous to billiard balls. The analogy has three components. The positive analogy contains the properties of billiard balls that are shared with gas molecules. The negative analogy contains the properties of billiard balls that are not shared by gas molecules. The neutral analogy contain those properties of billiard balls that are unknown or cannot be classified as positive or negative. A model can be either physical, such as the billiard balls, or mathematical. Hesse argues that models are essential for building theories and suggesting hypotheses:

If gases are really like collections of billiard balls, except in regard to the known negative analogy, then from our knowledge of the mechanics of billiard balls we may be able to make new predictions about the expected behavior of gases. Of course the **(p.7)** predictions may be wrong, but then we shall be led to conclude that we have the wrong model.

(Hesse 1966, 9)

It is not a great leap from metaphors and analogies to fictions and fables. Much of the work in this area is due to Nancy Cartwright. In her classic book, *How the Laws of Physics Lie*, Cartwright introduces her simulacrum account of explanation and makes the claim that "a model is a work of fiction. Some properties ascribed to objects in the model will be genuine properties of the objects modeled, but others will be merely properties of convenience" (Cartwright 1983, 153). The properties of convenience make mathematical theory applicable to the objects being modeled (Bailer-Jones 2009). In addition, Cartwright argues, in a view similar to ours, that models serve a variety of purposes, and any particular model should be judged according to how well it serves the purpose at hand.[4]

A more recent example comes from Godfrey-Smith (2006, 735), who notes that "modelers often *take* themselves to be describing imaginary biological populations, imaginary neural networks, or imaginary economies." He defines an imaginary population as one that, if it were real, would be a "flesh-and-blood" population. He suggests that these imagined populations should be treated as the imagined objects of literary fiction, such as Conan Doyle's London and Tolkien's Middle Earth. Again, in a view similar to ours, Godfrey-Smith claims that models are partial and provides an amusing example noting that when most people read *Lord of the Rings*, few imagine how many toes an orc has (2006, 735). In addition, he claims that we could describe these fictional worlds in mathematical terms, just like an economy, and we can easily compare them just as fiction fans might discuss the similarities between two fictional worlds (Middle Earth and Narnia) or the similarities between a fictional world and a real one (Middle Earth and medieval Europe) (737).

In later work, Cartwright (1991) defends a claim that the relationship of moral to fable is like the relationship of scientific law to model. The argument is that fables transform the abstract into **(p.8)** the concrete by providing "graspable, intuitive content for abstract, symbolic judgments" (58). The moral is a symbolic claim, and the fable provides specific content. Models work in the same way, giving specific content to scientific laws, which are symbolic. Laws are true in models just as morals are true in fables. Thus, a model "fits out" a scientific law by providing a concrete example where the law holds.

Noted economist Ariel Rubinstein also sees models as fables or fairy tales (2006, 881). The difference in the accounts is that Cartwright is concerned with the abstract versus the concrete, whereas Rubinstein claims that both models and fables parallel situations in the world and both impart a lesson. For Rubinstein, a fable, like a model, abstracts from irrelevant detail and may seem unrealistic or simplistic. This lack of detail may allow us to see connections that might otherwise remain hidden. Although fables exist in a netherworld between fantasy and reality, they teach us something—a moral or a lesson—about the world, and those lessons can have significant consequences. Models, therefore,

are neither of the real world nor completely divorced from it. Rubinstein's (2006, 882) conclusion is that it makes no more sense to test a model than it does to test a fable.

In a final account, Morrison and Morgan (1999b) see models as mediating instruments. That is, models stand, or mediate, between theories and the world and are partially independent of both. This partial independence arises from the ways scientists construct models. Built from bits of theory, bits of data, and a structure that may be mathematical, models comprise a "mixture of elements," including some from outside the field of inquiry (Morrison and Morgan 1999b, 14). Although models are only partially independent, they can function autonomously as instruments to aid scientists in the exploration of both theories and the world. This learning occurs not only through the construction of models (learning occurs when modeling choices are made) but also through the manipulation or use of models. The authors point to the urn model in statistics as an example of a model (in this case a thought experiment) that has taught generations of students the behavior of certain probability laws.

(p.9) These accounts have a number of points in common. They all describe models as partial representations of objects of interest. They all note the limited accuracy of models. Finally, they all argue that models reflect the interests of the user either through the choice of metaphor or analogy or fable or through their construction and subsequent use. These accounts also differ in a particular way. The first four describe models as linguistic entities: metaphors, analogies, fictions, or fables. In the final account, models are more similar to tools or instruments, which is also true of our account, presented in Chapter 3.

1.3 THE BROAD THEMES OF THE BOOK

Five major themes or principles can be found throughout the book: science is not what we think it is; current practice is not "philosophy-free"; models are objects; models are not tested with data, but with models of data; and theoretical models are a necessary component of explanations. These themes form the core of our book, and understanding them is essential to putting the "scientific" part of political science on a firmer foundation.

1.3.1 Science Is Not What We Think It Is

By and large, political scientists, and social scientists in general, know very little about the mechanics of the modern natural sciences. If there is one thing that philosophers of science, who go out and study the natural sciences, can teach us, it is that the practices of the natural sciences are not as we imagine them (Cartwright 1983). No one actually knows what it means for a discipline to be scientific, and any set of rules we could write down would be found to be violated routinely in fields regarded as indisputably scientific. There is no such thing as *the* Scientific Method, and most philosophers have given up the search for a single set of practices that defines one field as scientific and another as not

(Laudan 1983; Caldwell 1988). Many of the features of a discipline that we think of as scientific come from nineteenth-century classical **(p.10)** physics, which holds little relevance for modern physics and even less for the modern social sciences (Giere 1984).

The question of how to divide the scientific from the nonscientific is known as the demarcation problem, and the attempt to solve it most familiar to political scientists is Popper's (1968) falsifiability criterion, which remains a touchstone for some political scientists and some political science methodology texts such as King, Keohane, and Verba (1994). Examples abound, however, of pseudo-sciences with some falsifiable theories (e.g., astrology) and legitimate natural sciences with some nonfalsifiable theories (e.g., biology and physics) (Laudan 1983).[5] Falsifiability is simply neither a necessary nor a sufficient condition for a field to be deemed scientific.

The scientific status of political science was of great concern to modern pioneers, such as William Riker, as they sought to reshape the field. Since that time, political science has matured into a full-fledged discipline that no longer needs to defend its methods to those outside the profession (although we may still argue about those methods within the profession). The only people who still care about the scientific status of political science are political scientists motivated by a largely unnecessary academic inferiority complex. For those who remain concerned, we therefore stipulate that political science is scientific. It is an easy declaration to make given that no workable definition of "scientific" exists. The claim is essentially meaningless.

1.3.2 Current Practice Is Not "Philosophy-Free"

Thinking through the implications of a model-based science and understanding the role that models play in political science unavoidably requires some discussion of the philosophy of science. The topic is not popular among practical political scientists. The prevailing view seems to be that any discussion of the philosophy of science is a diversion and a waste of time. After all, there is real work to be done. King, Keohane, and Verba (1994)'s influential text, for example, avoids "abstract philosophical debates" (3) and "issues in the philosophy of science" (6). The subject is studiously avoided in most of Brady and **(p.11)** Collier (2004), with the exception of McKeown (2004), and never appears in Morton (1999).[6] One prominent political scientist has been known to state that he will turn to the philosophy of science once he has retired from doing actual political science.

This antipathy toward the philosophy of science is one part of an interesting dualism that exists in political science. The same political scientists who denigrate philosophical discussion have strong and often unyielding opinions on what Science is and how Science works. As the epigraph to this chapter suggests, these opinions neither form in a vacuum, nor are they the product of

observation. King, Keohane, and Verba (1994), while eschewing philosophical debate, firmly commit themselves to a particularly old brand of positivism that has not been current in half a century, all while presenting their ideas regarding research design as being based on underlying rules of inference that exist independently of philosophy. (See Johnson [2006] for a thorough discussion of the positivist commitments made by King, Keohane, and Verba [1994].) The opinions of others are influenced by limited introductions to the works of Karl Popper, Imre Lakatos, and Thomas Kuhn, or by high school and college chemistry or physics textbooks with sidebars on the Scientific Method. In many cases, researchers no longer remember the origins of these practices and have come to believe that political science research is simply done that way. Time and again, our current methodological practices are presented as "philosophy-free." Such claims are baseless.

Research practice in political science currently revolves around theory testing. A theory is proposed, an implication is derived from it, and the implication is then tested with data. If the implication is upheld in the data, the theory is deemed confirmed. If not, the theory is deemed unconfirmed. This procedure is known as the hypothetico-deductive method, and it lies at the heart of Popper's falsificationism and statistical hypothesis testing. More importantly, the procedure is central to much current research in political science. In making this case, we cite numerous examples from the leading journals and the seminal books in the field. Hypothetico-deductivism (H-D) even permeates books on political science research, some of which mention **(p.12)** H-D explicitly, such as Green and Shapiro (1994) and Elster (2007), and others that do not, such as Morton (1999). Even proponents of the Empirical Implications of Theoretical Models (EITM) project such as Aldrich and Alt (2003), Granato and Scioli (2004), and Granato, Lo, and Wong (2010), who relentlessly argue for H-D, never mention it by name or discuss its origins in the field.

H-D is far from "philosophy-free"; it is the subject of a wide-ranging literature in philosophy, much of it critical. We trace the rise of H-D in our discipline, showing how a group of philosophers known as the logical positivists influenced political scientists such as Riker. Our purpose in introducing some philosophy of science is not to argue that we should be deeply engaged in philosophical debate or slavishly devoted to the latest philosophical pronouncement, but rather to illuminate the influence of old philosophies on modern social scientific practices and ask whether these procedures are justified in the context of a model-based science. It is telling that models, which are so central to modern science and political science, play almost no role in those older philosophies.

1.3.3 Models Are Objects

As noted earlier, any political scientist with a model will quickly and cheerfully tell anyone who will listen that of course his or her model is false.[7] Such a declaration, however, implies something very specific about the nature of

models: that models are capable of being true or false. This way of thinking about models is a holdover from the philosophy of the mid-twentieth century when proponents of the so-called Received View argued that scientific theories comprised sentences or propositions, which can be true or false. The Received View enjoys little or no currency today outside of the social sciences, where its influence generally goes unrecognized. If there is one thing that those who think deeply about models agree on, it is that models are actually not truth-apt (Contessa 2009).

The modern approach sees models as objects; to ask whether an object is true or false is to make a category mistake. Objects are neither. **(p.13)** Toy airplanes, teapots, and trees are not capable of being true or false any more than models are. Thinking of models as objects is intuitive when it comes to three-dimensional models, such as the miniatures used by architects to communicate ideas to clients or Matchbox cars. It is far less intuitive to think of models as objects when it comes to the mathematical models used in the social sciences. All models, however, are representations, and representations are objects that stand in for other objects. We study one thing, the phenomenon, by studying another thing, the model. Thus, instead of studying the U.S. Congress directly, we create a model of the Congress and investigate the model. Once we are willing to view models as objects, the correct question to ask is not whether the model (object) is true or false but whether the model (object) is useful for achieving some purpose.

We go beyond arguing that models are objects; we argue that models are like particular kinds of objects—maps. We stress repeatedly that models share many of the properties of maps. Like maps, models have limited accuracy, models are partial, and most importantly, models are purpose-relative. The way to judge a map is to ask not whether it is true or false but whether it is useful for a specific purpose. The same holds for models; truth or falsity is irrelevant. The true measure of a model is usefulness, and we detail the different ways that theoretical and empirical models can be useful.

Theoretical models, we argue, can be useful in any one or more of four different roles: foundational (providing a basis for further model building or constructing a flexible and adaptive model), organizational (collecting disparate empirical generalizations, theoretical results, or set of facts under a single framework), exploratory (investigating mechanisms or motivations underlying phenomena of interest), and predictive (generating comparative statics). Empirical models are useful in one or more of three different roles: prediction (postdicting and forecasting), measurement (improving the quantification of difficult concepts), and characterization (describing data and spotting provocative associations). We argue that a fourth use of empirical models, theory testing, is the one for which they are least suited. **(p.14)** Though we do not insist on precisely these

particular categorizations, we do insist that usefulness is the correct criterion for judging models.

1.3.4 Models Are Not Tested with Data

Political scientists often talk and write about testing their models with data. Indeed, much of the recent action in political methodology has concerned the EITM project, which focuses on the testability and testing of theoretical models. The argument is that confronting theoretical models with data brings with it a number of benefits, including more grounded theoretical models, less whimsical empirical models, and fewer irrelevant deductions.

One problem with this formulation is that theoretical models are not tested with data. Rather, theoretical models are confronted with models of data, which we also refer to as data models or empirical models. These kinds of models share all the attributes of theoretical models: they are partial, have limited accuracy, and are purpose-relative. A data model acts as a map of the relationships and dependencies within a data set.

The question now becomes how do two models—both of which are limited, partial, and purpose-relative—comment on one another? How precisely does an empirical model test a theoretical model? Why do political scientists privilege the empirical model (that which does the testing) over the theoretical model (that which is tested) when both are models?

1.3.5 Explanation

Empirical models cannot test theoretical models, and often such tests are unnecessary given the nature of theoretical models. There are instances, however, where theoretical and empirical models interact. Explanation is one of those instances. Although political science is rife with all manner of debates (e.g., rational choice versus anti-rational choice; qualitative versus quantitative), there is nearly universal agreement that explanation is an important goal.

(p.15) There is less agreement about what constitutes an explanation. For many political scientists, demonstrating that x causes y amounts to an explanation. We challenge that view and argue that empirical models cannot provide explanations independently of theoretical models because empirical models provide neither arguments nor mechanisms. Explanations, therefore, must comprise either a theoretical model or a theoretical model and an empirical model.

Choosing between explanations that contain both a theoretical model and an empirical model is possible only in a relative sense. That is, using model discrimination techniques, we can say (albeit with uncertainty) that one explanation is better than another explanation. Both explanations, however, may be bad. Often, choosing between explanations is unnecessary. Seemingly rival

explanations may simply be addressing different questions or addressing parts of a complex situation.

1.4 PLAN OF THE BOOK

In Chapter 2, we paint a picture of where political science is at this moment in time. We do that by directly quoting from the work of top researchers in the field. The books from which we quote serve as exemplars for other faculty and, most importantly, for graduate students. We demonstrate that these books all rely on H-D. We discuss H-D in detail and show how it underlies commonly accepted parts of our methodological approach, such as falsificationism and classical hypothesis testing. After demonstrating the pervasiveness of H-D in political science, we detail the problems associated with H-D that have led many outside of the social sciences to abandon it. In particular, we show that the deductive structure of H-D prevents us from learning anything about the model that we did not already know. Finally, we trace the influence of H-D in political science to Riker's commitment to logical positivism. We argue that Riker's commitment is carried on today by two seminal methodology texts and the EITM project.

In Chapter 3, we answer the question, "what is a model?" Our broad claim is that models share many of the same properties as maps; indeed, **(p.16)** little damage is done to the concept of a model to think of models as maps. An extended discussion of maps illuminates those properties they share with models—maps are not truth-apt, maps have limited accuracy, maps are partial, and maps are purpose-relative. We then contrast the Received View of models, the view of models associated with logical positivism, with its successors, the Semantic Conception and the model-based view. Where the former is concerned with theories and truth, the latter deal with models and representation. The chapter ends with a discussion of the relationship between theories and models. Theories, on the model-based view, are simply collections or sets of models and are of minor importance when compared with models.

Chapter 4 is devoted to theoretical models, which are characterized by their reliance on deductive reasoning, their technique (e.g., social choice and game theory), and their level of abstraction. We argue that there are many ways to categorize models, but in keeping with our focus, we create a classification scheme that is consistent with usefulness and purpose. Models serve in any one or more of four different roles: foundational, organizational, exploratory, and predictive. We argue that models should be judged not by how well they predict, which is a common standard, but by how useful they are. This approach avoids the arbitrary precision of cookbook methodologies, but properly calls attention to the role of taste in choosing between theoretical models.

Empirical models are the subject of Chapter 5. We begin by defining what an empirical model is and its relationship to the data. We discuss how to

understand an empirical model under the model-based account. We argue that empirical models can be useful in one or more of three ways: prediction, measurement, and characterization. We pay particular attention to theory testing as the most common use of empirical models and the use to which empirical models are least suited. We demonstrate that the combination of an H-D relationship between the theoretical model and the hypothesis to be tested and an H-D relationship between the hypothesis to be tested and the data prevents model testing. This logic holds regardless of **(p.17)** the statistical approach—falsificationist, verificationist, or Bayesian— taken. We then address the other uses of empirical modeling in part by presenting examples of such models drawn from the political science literature that eschew theory testing while remaining useful and, by most accounts, scientific.

Chapter 6 begins with a question. How do theoretical and empirical models interact? Theoretical models are not confronted with data, but with models of data, or empirical models. Theoretical models and empirical models represent different things; given that there is no testing relationship, or even a strictly logical relationship, between them, what is the nature of their interaction? We consider existing justifications for combining theoretical and empirical models and find them wanting. We argue for a new justification based on the premise that theoretical models are necessary components of explanations. We discuss two broad conceptions of explanation, the unification approach and the causal-mechanical approach, and show that political scientists make use of both. An introduction to choosing between explanations in a relative sense and whether choosing is always necessary ends the chapter.

We conclude in Chapter 7 by addressing many of the criticisms that the arguments made in this book have raised.

1.5 WHAT THIS BOOK IS NOT

Although this book may be many things, there are a few that it is not. First, this book is about models in political science. It is not about building, solving, or estimating models; those skills are learned in graduate training programs. Rather, it is a book on understanding the role that models play in political science once they have been written down. Those interested in learning to construct and solve theoretical models should consult Ordeshook (1986), Kreps (1990), Fudenberg and Tirole (1991), and Gibbons (1992). Those interested in learning to construct and estimate empirical models should consult Davidson and MacKinnon (1981), Wooldridge (2002), Greene (2003), and Cameron and Trivedi (2005).

(p.18) Along the same lines, our book is not a cookbook in the sense of providing recipes, which if followed precisely every time, will produce a consistently sapid outcome. In a world where *the* Scientific Method does not exist, there are simply too many different combinations of ingredients,

temperatures, and cooking times (to stretch a metaphor) that can produce good work. Our book is rather one of first principles in which we help researchers think more carefully about their models and avoid making claims that are antithetical to the nature of models.

This book is also not a primer on the philosophy of science or the philosophy of economics. We draw on these disciplines selectively and discuss only a tiny fraction of the issues they raise. Those interested in broader introductions to the philosophy of science should consult Suppe (1977), Chalmers (1982), Salmon et al. (1992), and Boyd, Gasper, and Trout (1993). Hausman (1992) and Stigum (2003) are the "go-to" sources for the philosophy of economics. Those directly interested in models should look at van Fraassen (1980), Rappaport (1998), and Bailer-Jones (2009).

This book has little to say directly about qualitative research, experimental research, and computational modeling. These topics are not featured not because they are unimportant but because the conversation in political science in recent years has revolved around formal models and statistical models (mostly due to the EITM project). That being said, we see no reason the argument we make in this book should not apply to these parts of the discipline. In fact, it seems that a model-based view of science would be a particular boon to computational modelers, who are still struggling to gain acceptance within political science. There is some evidence, as we note in Chapter 3, that computational modelers in political science already think in ways that are similar to our approach.

Finally, our book is not an attempt to limit what the field views as good work. We are neither opponents of rational choice, nor do we claim that theoretical and empirical models have nothing to say to one another. Whereas the definition of good work in political science has narrowed to comprising a formal model (or at least a detailed soft model) matched with an empirical model that serves as a test **(p.19)** of the formal model, we provide a number of examples in chapters 4 and 5 of theoretical models that are useful without being tested and empirical models that are useful without having been derived from a formal model. One of our goals is to get the field to acknowledge and appreciate a wider range of scholarship as being good and useful.

Notes:

(1.) We do not mean to imply that all of political science concerns models. Normative theory is one example of an area where models are less central.

(2.) "*S* uses *X* to represent *W* for purposes *P*" (Giere 2006, 60).

(3.) Any emphasis is from the original source in all quoted material throughout the book, unless otherwise noted.

(4.) We do not, however, argue that models are fictions.

(5.) The falsifiability criterion only states that a claim be refutable; any claim that can be tested, however nonsensical, cannot be pseudo-scientific.

(6.) Green and Shapiro (1994) is the rare political science book that includes discussions of issues in the philosophy of science.

(7.) Most scholars are aware of the old saw attributed to George Box that “all models are wrong, but some are useful.”