PART I

EITM

Background and Framework
EITM is a natural outgrowth of prior modeling and testing approaches – research methods – aimed at fostering social scientific cumulation. The enduring effort – instituting the ideas – to create modeling and testing methods is of vital importance to the social sciences since it “provides a shared language so that even scholars thinking problems with little substantive overlap… can communicate efficiently and productively. It means that we begin with common first principles, and proceed with our research in a way that is commonly understood” (Gerber 2003, 3). Or, as Pearson (1957, 2004) states: “the unity of all science consists alone in its method, not in its material… It is not the facts themselves which make science, but the method by which they are dealt with” (page 12).

With the attributes of shared (and improving) standards, language, and technical-analytical competence, research methods allow us to find ways to implement the fundamental scientific ideas of order, cause, and chance (Bronowski 1978).  


2 The American Heritage Dictionary definition of science is “[t]he observation, identification, description, experimental investigation, and theoretical explanation of phenomena.”

3 Order is defined as “the selection of one set of appearances rather than another because it gives a better sense of the reality behind the appearances” (Bronowski 1978, 48). Order can require devices that depict relations and predictions. Abstract models and the use of mathematics are natural devices. Cause – determining what brings about an effect – was thought by early social scientists (or more accurately political economists) to be a sequential process (see Hoover 2001a, 1–28 for a review of David Hume’s influence). For an extensive treatment see Pearl (2000), but see also Kellstedt and Whitten (2009, 45–66) and Zellner (1984, 35–74) for a discussion of causality in applied statistics and econometrics, respectively. As for the concept of chance, Bronowski (1978) is critical of what he believes is the misuse of the term “cause” and prefers to link it with probabilistic statements – “chance” – which “replaces the concept of the inevitable effect by that of the probable trend” (page 87). Modern conceptions on the utility of mathematics also point to how applied statistical analysis aids in the idea of chance (e.g., statistical significance).
I.1 THE UTILITY OF MODELS AND MODELING

Order, cause, and chance can be effectuated by the use of models describing hypothetical worlds whose predictions have testable potential and assist in the systematization of knowledge. With models one may “put all these effects together, and, from what they are separately … collect what would be the effect of all these causes acting at once” (Sowell 1974, 137–138). As Gabaix and Laibson (2008) argue:

Models that make quantitatively precise predictions are the norm in other sciences. Models with predictive precision are easy to empirically test, and when such models are approximately empirically accurate, they are likely to be useful. (page 299)

If models possess attributes that enhance the scientific process, then how do we go about constructing them? Valid models make use of both deductive and inductive inference. Deductive inference, where “the conclusion is obtained by deducing it from other statements, known as premises of the argument. The argument is so constructed that if the premises are true the conclusion must also be true” (Reichenbach 1951, 37).

Inductive inference – because it relies on making inferences from the past to predict the future:

... enables us to associate probabilities – cause and chance – with propositions and to manipulate them in a consistent, logical way to take account of new information. Deductive statements of proof and disproof are then viewed as limiting cases of inductive logic wherein probabilities approach one or zero, respectively. (Zellner 1984, 5)

Abstract modeling in the social sciences traces its origins to the early political economists. The initial modeling efforts were deductive in orientation. Mathematics and mathematical models were argued as an attribute for determining order and cause because their logical consistency can be verified using the available operations of mathematics. David Ricardo was one of the first to make use of “abstract models, rigid and artificial definitions, syllogistic reasoning,” and applied the conclusions from the highly restrictive models

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4 See Granato (2005) for a discussion of these issues.

5 The EITM framework can be applied to either observational designs or more controlled settings (see Freedman et al. 1998, 3–28 and Shively 2017). For a review of some of the more important developments on research design issues (e.g., counterfactuals) and causality see Morgan and Winship (2007) and Brady (2008). An example of multiple designs and multiple methods can be found in Poteete et al. (2010).

6 There are numerous discussions on the utility of formal analysis and modeling. In political science, see Wagner (2001) and Wagner (2007, 1–52) for a review of the ongoing debate over modeling and an application to theories of international relations. See Clarke and Primo (2012), Krugman (1994, 1998), Wolpin (2013), and Jasso (2002) for discussions in the fields of political science, economics, and sociology, respectively.

7 See Sowell (1974) and Landreth and Colander (2002), but for subsequent changes in the use of mathematics (see Weintraub 2002).
directly to the complexities of the real world (see Sowell 1974, 113; Landreth and Colander 2002, 113–115).

These early modeling efforts were not without detractors. Richard Jones, for example, argued modeling generalizations were invalid if they ignored things that exist in the world including institutions, history, and statistics. Robert Malthus, Jean Baptiste Say, and J. C. L. Sismonde also criticized attempts at premature generalization (Sowell 1974, 114–116).

These critics gave no consideration that mathematics might be used to contribute to conceptual clarity rather than to derive numerical predictions. Antoine Augustin Cournot pointed out that mathematical analysis was used “not simply to calculate numbers” but to find “relations” (Sowell 1974, 117–118). Yet, the criticisms endured. More than a century later Kenneth Arrow (1948) provided the following defense of mathematical modeling:

It is true that there are certain limitations of mathematical methods in the social sciences. However, it must be insisted that the advantages are equally apparent and may frequently be worth a certain loss of realism. In the first place, clarity of thought is still a pearl of great price. In particular, the multiplicity of values of verbal symbols may be a great disadvantage when it comes to drawing the logical consequences of a proposition. (page 131)

In the early 1920s, inductive inference – and linking cause to chance and providing a basis for regression analysis and econometrics – was given important support when the sampling distribution(s) for regression coefficients were established (Fisher 1922). This latter contribution was an important precursor to what has been called the “probability approach” to statistical inference (Haavelmo 1944) – and efforts to link deductive and inductive approaches using formal analysis and applied statistical tools.

1.2 Institutional Development

While EITM draws inspiration from the Cowles Commission, it would be a mistake to limit it only to Cowles. The EITM framework builds on a variety of formal institutions and organizations in the social sciences. These institutions – ranging from research organizations to university departments – developed and supported the antecedents to EITM. The entities supporting the creation

8 In the seventeenth and eighteenth centuries a break occurred between those who believed political economy should base its method on rigor and precision versus those who emphasized the certainty of the results. The debate focused in part on whether political economic principles should be founded on abstract assumptions or factual premises (Sowell 1974, 117–118).

9 There are numerous examples where the use of mathematical models uncover logical inconsistencies that would be more difficult to find using verbal argument(s). Viner (1958), for instance, discusses how the aid of mathematics leads to clarification on the uses of average and marginal cost.

10 An expanded sample can be found in Mitchell (1930, 1937, 58–71).
and development of formal and applied statistical analysis include (but are not limited to):

- The Social Science Research Council (SSRC).
- The Econometric Society and the Cowles Commission.
- The Political Science Department at the University of Rochester.
- The Society for Political Methodology.

1.2.1 The SSRC

The 1920s saw movement in the social sciences toward improving quantitative methods of study. One leading figure was Charles Merriam who worked to alter the methods of political study (Merriam 1921, 1923, 1924; Merriam et al. 1923). At that time, he believed the existing methods of analysis failed on a fundamental level – identifying underlying mechanisms:

> The difficulty of isolating political phenomena sufficiently to determine precisely the causal relations between them. We know that events occur, but we find so many alternate causes that we are not always able to indicate a specific cause. For the same reason we are unable to reach an expert agreement upon the proper or scientific policy to pursue and by the same logic we are unable to predict the course of events in future situations. (Merriam 1923, 288)

Merriam stressed the need to examine and use multiple methods from numerous social science disciplines (i.e., economics, statistics, history, anthropology, geography, psychology).

In place of literature Merriam favored a better organized and more consciously scientific and social psychological approach to the study of human behavior. Statistics and other empirical tools would play a critical role in shifting the political and social sciences closer to the “hard sciences.” (Worcester 2001, 16–17)

To accomplish these goals, Merriam proposed an interdisciplinary institution to help promote his vision – the SSRC. In the 1920s, the SSRC was considered the first national organization of all the social sciences, and from the outset its goal has been to improve the quality of, and infrastructure for, research in the social sciences. Among the contributions of the SSRC has been its multidisciplinary outlook and emphasis on creating and using data.

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11 Early political science examples can be found in Mayo-Smith (1890), Ogburn and Peterson (1916), and Ogburn and Goltra (1919).

12 Another important research institution, the National Bureau of Economic Research (NBER), was founded in 1920. The NBER had a narrower disciplinary focus (economics), but in many ways shared the same basic vision as the SSRC.
1.2.2 The Econometric Society and the Cowles Commission

The creation of the SSRC was followed by two other significant institutional developments.

The Econometric Society was established in 1930...The Society greatly facilitated academic exchanges between European and American scholars not only in the young econometrics profession but also in mathematical statistics. It thus rapidly promoted the growth of econometrics into a separate discipline. (Duo 1993, 5)

The Econometric Society sought to use mathematics and statistics to increase the level of rigor in the formulation and testing of economic theory. The society initially featured scholarly meetings and the creation of the journal *Econometrica*.

The Cowles Commission followed in 1932. It was a research institution which contributed uniquely to the formalization of econometrics (see Christ 1952; Hildreth 1986). The Commission had a close connection with the Econometric Society from its beginning. (Duo 1993, 5)

The Cowles Commission advanced the rise and adoption of econometric methodology in two ways. Recall that it developed the probability approach. This approach highlighted the issues of identification and invariance. Identification was central since a goal of econometrics is to determine the true values of the parameters among all the possible sets of values consistent with the data and with the known or assumed properties of the model.

The second issue was the invariance of a relation. If structure is known to remain in the future what it was in the past, and if the auxiliary variables have constant values through both periods, the path of each variable will be predictable from the past, apart from random disturbances. By addressing the

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13 Econometric research associated with the Cowles Commission includes (but is not limited to): Cooper (1948), Haavelmo (1943, 1944), Hood and Koopmans (1953), Klein (1947), Koopmans (1945, 1949a, b, 1950), Koopmans and Reiersol (1950), Marschak (1947, 1953), Vining (1949), Christ (1994), and Heckman (2000). For further background on the Cowles Commission consult the following URL: http://cowles.econ.yale.edu/.

14 The intuition behind the terms identify (i.e., identification) and invariant (i.e., invariance) are as follows. For applied statistical models identification relates to model parameters (e.g., $\hat{\beta}$) and whether they indicate the magnitude of the effect for that particular independent variable. Or, in more technical terms, “A parameter is identifiable if different values for the parameter produce different distributions for some observable aspect of the data” (Brady and Collier 2004, 290).

In applied statistical practice, invariance refers to the constancy of the parameters of interest. More generally, “the distinctive features of causal models is that each variable is determined by a set of other variables through a relationship (known as ‘mechanism’) that remains invariant (constant) when those other variables are subjected to external influences. Only by virtue of its invariance do causal models allow us to predict the effect of changes and interventions …” (Pearl 2000, 63).

15 An equation of a model is declared to be identifiable in that model if, given a sufficient (possibly infinite) number of observations of the variables, it would be possible to find one and only one set of parameters for it that is consistent with both the model and the observations.
issues of identification and invariance, the probability approach – and the linkage of formal and empirical analysis – provides a connection to falsifiability, predictive precision, and the workings of a system.\textsuperscript{16} We would add those models that have these properties also facilitate comparison between rival and competing theories over the same phenomena – and can enhance scientific cumulation (Kuhn 1979).

The Cowles approach also drew criticisms. These criticisms for the most part focused on measurement and inferences issues (Keynes 1940) and questions about predictive accuracy (Christ 1951). Despite the criticisms, the Cowles Commission approach was widely adopted and by the mid-1960s was standard in quantitative economics. However, during the 1970s more fundamental criticisms – regarding invariance and identification – arose.

In 1976, Robert Lucas questioned the robustness of invariance when the Cowles approach is used. His formal analysis demonstrated that models based on the Cowles approach were fundamentally flawed in their ability to evaluate the outcomes of alternative economic policies. The reason, he argued, is that in-sample estimation provides little guidance in predicting the effects of policy changes because the parameters of the applied statistical models are unlikely to remain stable under alternative stimuli.\textsuperscript{17}

Sims (1980) later challenged the identification procedures inspired by the Cowles Commission. Sims argued against the reliance on “incredible restrictions” to identify structural models. These restrictions had the effect of undermining an understanding of the system. Sims offered a change in emphasis from focusing on individual coefficients, as the structural modeling approach did, to

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\textsuperscript{16} Gabaix and Laibson (2008) argue that falsifiability and predictive precision are among the key properties of useful models (see Gabaix and Laibson 2008). “A model is falsifiable if and only if the model makes nontrivial predictions that can in principle be empirically falsified” (page 295). “Models have predictive precision when they make precise – or “strong” – predictions. Strong predictions are desirable because they facilitate model evaluation and model testing. When an incorrect model makes strong predictions, it is easy to empirically falsify the model, even when the researcher has access only to a small amount of data. A model with predictive precision also has greater potential to be practically useful if it survives empirical testing. Models with predictive precision are useful tools for decision makers who are trying to forecast future events or the consequences of new policies” (page 295).

In the language of econometrics, falsification and predictive precision require the mechanisms relating cause and effect be identified. There is a large literature devoted to identification problems (see, for example, Koopmans 1949a,b; Fisher 1966; and Manski 1995), but we use identification in the broadest sense for purposes of attaining some order and underlying cause as well. Since we as social scientists do not have controlled environments to conduct our inquiry, our efforts to achieve order and cause in our models can only come about probabilistically – by chance.

\textsuperscript{17} The Lucas critique is based on the following intuition: “...given that the structure of an econometric model consists of optimal decision rules ... and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models” (Lucas 1976, 41).
vector autoregressive (VAR) modeling with attention given on the dynamic time series properties of an unrestricted (by theory) system of equations. Despite these challenges, some of the basic tools and procedures of the probability approach remain. One extension of the structural approach, in part a response to Lucas’ criticisms, is “real business cycle modeling” (RBC). Here the focus is on isolating parameters and on making greater explicit use of theory at both the individual and aggregate levels of analysis. Where RBCs especially differ from the Cowles Commission is in the use of standard statistical significance testing (see Chapter 11).

1.2.3 The Political Science Department at the University of Rochester

Thanks in part to the SSRC, there was a clear tendency in political science to promote statistical methods. Methodological emphasis was placed on statistical correlation and empirical testing and generally focused on psychological attitudes to derive empirical generalizations. During the late 1950s and early 1960s William Riker and later – the Department of Political Science at the University of Rochester – developed positive political theory.

The goal of positive political theorists is to make positive statements about political phenomena, or descriptive generalizations that can be subjected to empirical verification. This commitment to scientifically explaining political processes involves the use of formal language, including set theory, mathematical models, statistical analysis, game

18 Sims’ methodology is grounded in probabilistic inference, imposing only enough economic theory to identify the statistical models and carry out analyses of policy effectiveness. See Freeman et al. (1989) for an application of VAR to political science questions.
19 See Freeman and Houser (1998) for an application in political economy (see Chapter 11 as well). For a critique of RBCs see Sims (1996).
20 The method involves computational experiments. These experiments rely on a sequence of steps including: deriving the equilibrium laws of motion for the model economy from “well-tested theory,” “calibrating” the model using parameter values derived from historical data, generating simulated realizations of the equilibrium processes, determining the sampling distributions of the statistics computed from the simulated data, and comparing these statistics to those computed for data from actual economies. Kydland and Prescott’s (1982) “computational experiments” are often referred to as “calibration” because of the use of parameter values derived from simple measures (such as averages) of historical time series to “calibrate” the theoretical models.
21 See Von Neumann et al. (1944), Black (1948), Arrow (1951) and Downs (1957) for the start of formal approaches to the study of politics by nonpolitical scientists.
22 A parallel development, in the early 1960s, was the creation of the Public Choice Society (https://publicchoicesociety.org). This society’s statement of purpose (https://publicchoicesociety.org/about) is to:
... facilitate the exchange of research and ideas across disciplines in the social sciences, particularly economics, political science, sociology, law and related fields. It started when scholars from all these groups became interested in the application of essentially economic methods to problems normally dealt with by political theorists. It has retained strong traces of economic methodology, but new and fruitful directions have developed that transcend the boundaries of any self-contained discipline.
theory, and decision theory, as well as historical narrative and experiments. (Amadae and Bueno de Mesquita 1999, 270)

Riker, while not averse to inductive reasoning, put an emphasis on the deductive approach. In particular,

The Rochester school has emphasized deriving hypotheses from axioms. Doing so reduces the risk that hypotheses are restatements of already observed patterns in the data. Even when models are constructed specifically to account for known empirical regularities, they are likely to produce new propositions that have not previously been tested. These new propositions, of course, create demand tests of the theory. Historical and statistical analyses tend not to hold the relations among variables constant from study to study and so are less likely to test inductively derived hypotheses against independent sources of evidence. (Amadae and Bueno de Mesquita 1999, 289)\(^{23}\)

The advent of positive political theory (and later game theory) provided another social science discipline – political science – the basis for a graduate training and research regimen that continues to grow to this day.

1.2.4 The Society for Political Methodology

In the early 1970s, political scientists began a process of enhancing the usage of applied statistical procedures.\(^{24}\) John Sullivan, George Marcus, and Gerald Dorfman created the journal *Political Methodology* (Lewis-Beck 2008). The journal was announced in 1972 and by 1974 the first issue was published. This journal was followed by the creation of the Society for Political Methodology in the early 1980s. Like the Econometric Society, the Society for Political Methodology developed annual meetings and a journal – *Political Analysis* – which succeeded the earlier *Political Methodology*.

The methodological improvements in political science have accelerated since the early 1970s and 1980s. Bartels and Brady (1993) noted political science had started a series of rigorous literatures in topics ranging from parameter variation and nonrandom measurement error to dimensional models. A summary of the increasing breadth of this society can be found in Box-Steffensmeier et al. (2008).

1.3 SUMMARY

The chapter briefly describes ideas and institutions that provide both the direction and a basis for EITM. These predecessors, while they have some similarities, also have distinct identities ranging from data analysis, multidisciplinarity, applied statistical analysis, formal analysis, and the linkage of the

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\(^{23}\) See Amadae and Bueno de Mesquita (1999) for a list of publications associated, in part, with the Rochester School.

\(^{24}\) We thank Christopher Achen and Elinor Ostrom for the background information.