

**Overview of Research Methodologies  
for  
Environmental Compliance and Enforcement**

14 Oct 2005

## Table of Contents

<b>1</b>	<b>INTRODUCTION.....</b>	<b>3</b>
<b>2</b>	<b>BACKGROUND TO METHODOLOGICAL THINKING.....</b>	<b>3</b>
	2.1 Conceptual challenges to evaluating variables.....	3
	2.2 Defining causality and constructing causal theories.....	7
	2.3 A general distinction between qualitative and quantitative techniques.....	9
<b>3</b>	<b>RESEARCH METHODOLOGIES.....</b>	<b>10</b>
	3.1 Case Studies.....	10
	3.2 Process Tracking.....	12
	3.3 Counterfactuals.....	13
	3.4 Qualitative Comparative Analysis.....	14
	3.5 Quantitative Statistics.....	16
	3.6 Meta-analysis.....	18
	3.7 Legal Research Methodologies .....	19
	3.7.1 Legal research for practicing lawyers.....	19
	3.7.2 Legal scholarship.....	23
<b>4</b>	<b>TOOLS FOR APPLYING USABLE KNOWLEDGE.....</b>	<b>31</b>
	4.1 Diagnostic tools for designing institutions.....	31
	4.2 Scenarios.....	33
	4.3 Simulation modeling.....	35
	4.4 Resilience, vulnerability, and adaptation.....	37
	<b>Bibliography.....</b>	<b>38</b>

# Overview of Research Methodologies for Environmental Compliance and Enforcement<sup>1</sup>

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## 1 INTRODUCTION

This paper surveys research methodologies for evaluating environmental compliance and enforcement (ECE), most of which have their own long and established histories from the social and natural sciences. This paper benefits from this history of scholarship by relying, almost exclusively, on excerpts from some of the best current thinkers in research methodologies, and particularly from those whose background is in regime analysis.

The paper begins with a discussion of major issues that are common to all methodologies. We then move on to examine the methodologies with a section focused, less on the detailed mechanics of how a given research method is carried out, and more on the types of data that are suitable for a methodology, what types of results we can obtain from it, and its benefits and limitations. The final section discusses techniques which sit somewhere on the fuzzy boundary between research methodologies and planning tools. In many ways these are the bridge between the researcher and the practitioner, as they take the wisdom or knowledge accumulated from research and try to focus it forward onto how we design ECE systems.

## 2 BACKGROUND TO METHODOLOGICAL THINKING

### 2.1 Conceptual challenges to evaluating variables

While occasionally the ECE researcher may be working with clear numeric values (i.e., tonnes of CO<sub>2</sub> emitted), far more often they must work with much more nebulous concepts: effectiveness, or equity. How to measure or construct these variables will be important to many ECE research programs.

#### The Consequences of International Regimes

Oran Young, 2004

...[A]mong those concerned with the internal effects of regimes, a number of conceptual issues remain to be resolved. First and foremost is the need to pin down the dependent variable(s). Although most analysts concerned with simple effectiveness would agree with the idea of problem solving as the ultimate target of analysis, delineating the causal role of regimes in solving well-defined problems is a tall order. One response to this difficulty is to introduce a distinction—familiar to students of public policy—among outputs, outcomes, and impacts (Easton 1965). The study of outputs ... directs attention to matters like the promulgation of regulations designed to operationalize rules and the

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<sup>1</sup> This memo was prepared by Daniel Hall, a masters student at Bren, and edited by Thomas Higdon, Esq., a consultant to INECE. Section 3.7 was done by Dave Grossman, a staff attorney with the Institute for Governance & Sustainable Development.

development of policy instruments intended to guide the behavior of key actors ... (Chayes and Chayes 1995; Weiss and Jacobson 1998). Outcomes, by contrast, involve measurable changes in the behavior of regime members and those subject to their jurisdiction. . . . (Levy, Young, and Zürn 1995; Young 1999b). For their part, impacts are best construed as the contributions regimes make to solving the problems that lead to their creation in the first place . . .

### Methodological Challenges in the Study of Regime Effectiveness

Arild Underdal, 2004 (footnotes omitted)

#### **Assessing Regime Effectiveness**

From a methodological perspective, assessing the effectiveness of an institution means comparing its observed or predicted performance against some standard of “success”. Any attempt at developing a methodological framework for such an exercise must, then, address at least three main questions. First, what precisely is the *object* to be assessed? Second, against which *standard* is this object to be evaluated? And, third, *how* do we—in operational terms—go about comparing that object to the standard we have defined? Methodological approaches to the study of regime effectiveness can be described and distinguished in terms of their answers to these three questions.

#### **The object**

The question about the object to be assessed may at first thought appear trivial; the object must clearly be the regime in focus . . . [F]urther clarification is required on at least two dimensions: First, what exactly do we study the consequences *of*? Do we focus only on the norms, rules and regulations that make up the regime itself, or do we include also the political *processes* through which it is established and operated? Second, *where* in the chain of consequences do we enter to assess effectiveness? Let us briefly examine the main options and explore the implications of the choices we make.

A regime is conventionally defined as a set of norms, rules and regulations supposed to govern a particular system of activities. All research on regime effectiveness tries to determine to what extent and how this body of norms and rules influence the behaviour of parties and target groups . . . These *processes* generate their own consequences, distinct from but also related to those that can be attributed to the body of rules they establish, modify or implement. International negotiations tend, for instance, to generate their own stakes for the governments involved, *inter alia*, in the form of incentives to do well in the eyes of domestic constituencies and important others. Similarly, international negotiations are often large-scale exercises in social learning, leading at least some of the parties involved to change their perception of the problem and their evaluation of alternative policy options. As a consequence, parties may well make *unilateral* adjustments of behaviour, even in the absence of any legal or political obligation to do so.

...

We can now see that the distinction between effects that can be attributed to the regime itself and those that can be attributed to regime formation and operation *processes* is not merely a matter of academic hair-splitting. Not only may the score we end up with depend critically on whether we include process-generated effects or not; also the advice we would give to policy-makers may well depend on which of these perspectives we adopt.

The default option is to focus only or at least primarily on consequences that can be attributed to the regime itself . . . We should, though, be aware of its implications, and

make sure that our choice is explicit and transparent. A more ambitious goal for the longer term should be to improve our analytical and methodological grasp also on process-generated effects. ...

Most regimes produce a *chain* of consequences, and effectiveness can be measured at different points in this chain. To simplify matters, we can draw a distinction between effects on human behaviour (here referred to as *outcome*) and effects on the problem allegedly caused by this behaviour (*impact*). For example, when we are dealing with an environmental regime it makes sense to distinguish between its effect on (target group) behaviour (e.g. industry emissions of polluting substances) and its impact upon the state of the environment. A regime cannot improve the state of the environment without changing human behaviour, but it may well change human behaviour—even as intended—without improving the state of the environment. ... In these and many other cases the score of effectiveness that we would assign to a regime would obviously depend on our choice of entry point; assessments referring to outcomes would show higher effectiveness than assessments of impact.

Impact is, presumably, the ultimate concern of decision-makers and stakeholders. Yet, most assessments of effectiveness focus mainly or exclusively on changes in human behaviour. Good reasons can be given for this order of priorities. One is simply that whatever the ultimate purpose, human behaviour is always the immediate target of regulation . . .

#### ***The standard***

To be able to assign a score of effectiveness to a particular regime we need a standard of evaluation. Such a standard should fulfil two important functions. First, it should define a point or trajectory against which actual performance can (easily) be compared. Second, it should provide a common metric of measurement that can be applied across a wide range of cases. It seems fair to say that the tools we have at present perform the former function better than the latter.

With regard to points of reference, there seems at the most general level to be two principal alternatives. One is the hypothetical state of affairs that would have come about had the regime not existed. This is clearly the standard we have in mind when arguing that “regimes matter” or “improve” a particular state of affairs. The other option is to evaluate achievements against some idea of what constitutes a “good” or “optimal” solution. This is the appropriate standard if we want to know whether and to what extent a problem is in fact “solved” under present arrangements. These two standards can easily be combined, as suggested by Helm and Sprinz (1999; see also Sprinz and Helm, 1999). Their formula conceptualises the effectiveness of a regime in terms of the extent to which it *in fact* accomplishes all that *can be* accomplished.

#### ***Operational procedure***

Let us assume that we know the state of affairs that obtains with the regime in place, and that we have some metric that enables us to assess effectiveness in crude ordinal-scale terms, i.e., to distinguish “less” from “more”. The remaining challenge, then, is to determine whether, in what respects, and to what degree the state of affairs that we observe with the regime in existence differs from the hypothetical state of affairs that would have come about in its absence (and, perhaps, also from an “ideal” solution).

This is a question that can be answered only through counterfactual analysis, in two steps. First, we have to determine what “*order*” would have existed in the absence of the present regime. The default option is to assume that the order that existed immediately

prior to the establishment of the present regime would have continued unchanged. There is nothing substantively compelling about this assumption; it is . . . a convenient and often plausible assumption, and I will adopt it here for exactly those reasons. That leaves me free to concentrate on the second step, which is that of determining what would have happened under the previous order.

There are two main categories of methodological approaches to this latter question. One relies on simple *extrapolation*. The key assumption here is that the future will be a linear extension of the past. This assumption is most often specified in terms of *trends*; the direction and rate of change is assumed to be constant. . . . What makes this approach attractive is its combination of operational feasibility and intuitive plausibility. With appropriate time series data, linear extrapolation is technically a very straightforward exercise. Moreover, most systems of activity seem in fact to be fairly stable most of the time. This suggests that as long as it is used cautiously for short time spans, linear extrapolation should more often than not produce plausible estimates. The obvious problem with this method is that it is devoid of theoretical substance; it specifies no driving forces or feedback mechanisms. In fact, the underlying “model” has *time* as its only independent variable. This is clearly not a satisfactory solution. Even though most systems are fairly stable most of the time, non-linearity and inflection points are too important phenomena to be ruled out by definition (see Doran, 1999).

The only alternative that enables us to deal systematically with non-linearity is an approach that builds on some kind of model identifying what we assume to be the main determinants of change and stability in the system of activities we study. If we are dealing with a pollution control regime such a model should, ideally, identify the critical factors assumed to affect emissions of the substances targeted, and specify how these factors—individually and jointly—determine the volume of emissions. In terms of theoretical merit, this kind of approach is clearly superior to that of linear extrapolation. It is, however, also a more demanding approach; constructing and applying a model that meets both of the two requirements specified above can be a tall order, often requiring expertise well beyond the discipline of political science (or, for that matter, law or economics). . . .

### **Explaining Regime Effectiveness**

. . . Any attempt at explaining variance must first of all try to identify the critical “determinants” of effectiveness. Previous research has identified a wide range of independent variables that seem to have made a significant difference in some particular case(s). To simplify things, we can categorize most of these variables into three main clusters: the nature of the *problem*, characteristics of the *group of parties*, and properties of the *regime itself*.

Few would dispute the general proposition that some problems are harder to solve than others. The challenge is to specify precisely what makes a problem “difficult” to solve, and to determine to what extent specific problems in fact exhibit these features. . . .

A second path of research departs from the assumption that some groups of actors have greater *capacity* for collective action than other groups. The challenge here becomes to determine more precisely which group characteristics enhance that capacity, and to what extent particular groups possess these characteristics. . . .

Finally, effectiveness depends to some degree on properties of the regime itself. For example, some regimes provide stronger (selective) incentives for co-operative behavior

than others. Some contribute through providing procedures, arenas or other facilities that enable parties to develop a base of consensual knowledge and shared beliefs. . .

## 2.2 Defining causality and constructing causal theories

Most ECE research programs will involve questions of causality, e.g., what caused program X to be effective while program Y failed? Assignations of causality can be facilitated by correctly constructing causal theories.

Designing Social Inquiry: Scientific Inference in Qualitative Research  
Gary King, Robert O. Keohane, and Sidney Verba, 1994 (footnotes omitted)

### *The Definition and a Quantitative Example*

Our theoretical definition applies most simply and clearly to a single unit... [A] unit is one of the many elements to be observed in a study, such as a person, country, year, or political organization. For precision and clarity, we have chosen a single running example from quantitative research: the causal effect of incumbency status for a Democratic candidate for the U.S. House of Representatives on the proportion of votes this candidate receives. (Using only a Democratic candidate simplifies the example.) Let the dependent variable be the Democratic proportion of the two-party vote for the House. The key causal explanatory variable is then dichotomous, either the Democrat is an incumbent or not. ...

Causal language can be confusing and our choice here is hardly unique. The “dependent variable” is sometimes called the “outcome variable.” “Explanatory variables” are often referred to as “independent variables.” We divide the explanatory variables into the “key causal variable” (also called the “cause” or the “treatment variable”) and the “control variables.” Finally, the key causal variable always takes on two or more values, which are often denoted by “treatment group” and “control group.”

Now consider only the Fourth Congressional District in New York, and imagine an election in 1998 with a Democratic incumbent and one Republican (nonincumbent) challenger. Suppose the Democratic candidate received a fraction of the vote in this election (the subscript 4 denotes the Fourth District in New York and the superscript  $I$  refers to the fact that the Democrat is an *Incumbent*).  $y_4^I$  is then a value of the dependent variable. To *define* the causal effect (a *theoretical* quantity), imagine that we go back in time to the start of the election campaign and everything remains the same, except that the Democratic incumbent decides not to run for re-election and the Democratic Party nominates another candidate (presumably the winner of the primary election). We denote the fraction of the vote that the Democratic (non-incumbent) candidate would receive by  $\underline{y_4^N}$  (where  $N$  denotes a Democratic candidate who is a *Non-incumbent*).

This *counterfactual* condition is the essence behind this definition of causality, and the difference between the actual vote ( $y_4^I$ ) and the likely vote in this counterfactual situation ( $\underline{y_4^N}$ ) is the causal effect, a concept we define more precisely below. We must be very careful in defining counterfactuals; although they are obviously counter to the facts, they must be reasonable and it should be possible for the counterfactual event to have occurred under precisely stated circumstances. A key part of defining the appropriate counterfactual condition is clarifying precisely what we are holding constant while we are changing the value of the treatment variable. . .

More formally, the causal effect of incumbency in the Fourth District in New York—the proportion of the vote received by the Democratic Party candidate that is attributable to incumbency status—would be the difference between these two vote fractions: ( $y_4^I - y_4^N$ ). ...[W]e refer to this difference as the *realized causal effect* . . .

Of course, this effect is defined only in theory since in any one real election we might observe *either*  $y_4^I$  *or*  $y_4^N$  or neither, but never both. Thus, this simple definition of causality demonstrates that we can never hope to know a causal effect for certain. Holland (1986) refers to this problem as *the fundamental problem of causal inference*, and it is indeed a *fundamental* problem since no matter how perfect the research design, no matter how much data we collect, no matter how perceptive the observers, no matter how diligent the research assistants, and no matter how much experimental control we have, we will never know a causal inference for certain. . .

### **Rules for Constructing Causal Theories**

. . . *Causal theories* are designed to show the causes of a phenomenon or set of phenomena. Whether originally conceived as deductive or inductive, any theory includes an interrelated set of causal hypotheses. Each hypothesis specifies a posited relationship between variables that creates observable implications: if the specified explanatory variables take on certain values, other specified values are predicted for the dependent variables. Testing or evaluating any causal hypothesis requires causal inference. ...

... In this section, we provide five rules that will help in formulating good theories...

#### *Rule 1: Construct Falsifiable Theories*

By this first rule, we do not only mean that a “theory” incapable of being wrong is not a theory. We also mean that we should design theories so that they can be shown to be wrong as easily and quickly as possible. . .

#### *Rule 2: Build Theories That Are Internally Consistent*

A theory which is internally inconsistent is not only falsifiable—it is false. Indeed, this is the only situation where the veracity of a theory is known without any empirical evidence: if two or more parts of a theory generate hypotheses that contradict one another, then no evidence from the empirical world can uphold the theory. Ensuring that theories are internally consistent should be entirely uncontroversial, but consistency is frequently difficult to achieve. . .

#### *Rule 3: Select Dependent Variables Carefully*

Of course, we should do everything in research carefully, but choosing variables, especially dependent variables, is a particularly important decision. We offer the following three suggestions (based on mistakes that occur all too frequently in the quantitative and qualitative literatures):

First, *dependent variables should be dependent*. A very common mistake is to choose a dependent variable which in fact causes changes in our explanatory variables. . .

Second, *do not select observations based on the dependent variable so that the dependent variable is constant*. This, too, may seem a bit obvious, but scholars often choose observations in which the dependent variable does not vary at all...

Finally, we should choose a dependent variable that represents the variation we wish to explain. ...

...[W]e need the entire range of variation in the dependent variable to be a possible outcome of the experiment in order to obtain an unbiased estimate of the impact of the explanatory variables. . .

*Rule 4: Maximize Concreteness*

Our fourth rule, which follows from our emphasis on falsifiability, consistency, and variation in the dependent variable is to maximize concreteness. We should choose observable, rather than unobservable, concepts wherever possible. Abstract, unobserved concepts such as utility, culture, intentions, motivations, identification, intelligence, or the national interest are often used in social science theories. They can play a useful role in theory *formulation*; but they can be a hindrance to empirical *evaluation* of theories and hypotheses unless they can be defined in a way such that they, or at least their implications, can be observed and measured. . .

*Rule 5: State Theories in as Encompassing Ways as Feasible*

Within the constraints of guaranteeing that the theory will be falsifiable and that we maximize concreteness, the theory should be formulated so that it explains as much of the world as possible. We realize that there is some tension between this fifth rule and our earlier injunction to be concrete. We can only say that both goals are important, though in many cases they may conflict, and we need to be sensitive to both in order to draw a balance. . .

## 2.3 A general distinction between qualitative and quantitative techniques

### Regime Effectiveness: Taking Stock Oran Young, 1999a (footnotes omitted)

[Assessing the effectiveness of international regimes] involves an effort to determine which of the changes captured in the before-and-after snapshots can be attributed, wholly or in part, to the operation of the regimes we have studied. In this area, our most significant conclusions involve the development of methods or analytic techniques for demonstrating causal connections. Specifically, the case studies have illuminated a distinction between two modes of reasoning that figure prominently in this stage of our inquiry: variation finding analysis and tendency finding analysis. In our judgment, these approaches to understanding complement and reinforce one another....

As David Dessler points out, variation finding analysis seeks to answer the question “under what conditions will international regimes be effective” and proceeds to respond to this question by framing hypotheses linking various factors to anticipated levels of effectiveness (Dessler 1992). The product of this sort of analysis is a set of propositions in which institutional effectiveness is treated as the dependent variable and a variety of factors (or combinations of factors) are singled out as independent variables.

Variation finding analysis works best in situations featuring large universes of cases that resemble one another as closely as possible. Under these conditions, it is feasible to draw representative samples and to deploy the techniques of statistics, including multivariate analysis, to measure the strength of the association among dependent variables and any of a number of independent variables. Unfortunately, these conditions are seldom present when it comes to the analysis of institutional arrangements in

international society. In this setting, we ordinarily deal with a small number of cases, and there are often good reasons to suspect that individual cases differ from one another in significant ways. Even so, the fundamental logic of variation finding analysis remains the same (King, Keohane, and Verba 1994). We are still interested in identifying “the conditions of institutional effectiveness” and framing hypotheses in which specific independent variables are linked to effectiveness treated as the dependent variable. Understandably, those who use variation finding analysis to study institutional effectiveness in situations where universes of cases are small are apt to favor hypotheses that state necessary or sufficient conditions. Because such hypotheses are expected to apply without exception, every case constitutes a critical test of the expected relationships as long as it belongs to the relevant universe of cases.

Tendency finding analysis, by contrast, highlights what is often called genetic explanation (Nagel 1961). Those who adopt this approach ask “how is it possible to solve problems in international society” and then seek to understand the roles that institutions play in such processes (Dessler 1992). This approach leads directly to a search for the mechanisms or pathways through which regimes can affect the behavior of their members. Such efforts do not yield generalizations asserting regular relationships between independent and dependent variables. Rather, they lead to insights concerning the mechanisms through which institutions influence the behavior of their members under a variety of conditions. . . .

Unlike variation finding analysis, tendency finding procedures seek to identify the particular combinations of forces at work in specific situations and to show how these combinations account for the outcomes that occur. Individual cases may be unique in the sense that the particular combinations of forces at work do not occur in any other cases. Yet the causal tendency associated with each of the individual forces may be similar from case to case. As a result, the testing of genetic explanations does not require a comparison of hypothesized regularities with empirical evidence relating to a collection of comparable cases. Instead, those who engage in tendency finding analysis often examine individual cases in depth, seeking to construct persuasive narrative accounts or stories using procedures they describe as process tracing or thick description. The objective here is to develop detailed accounts of individual cases rather to assemble data sets of the sort required to test the hypotheses flowing from variation finding analysis.

### **3 RESEARCH METHODOLOGIES**

We now turn to a review of the major methodologies available to ECE researchers. While not an exhaustive overview of methodologies, the goal of this section is to inform readers on the basics of all of the most significant methodologies used. In general this section is organized moving from more relatively qualitative methods towards the more quantitative, though we reserve the final part of this section for a review of legal methodology.

#### **3.1 Case Studies**

The opening selection by Underdal succinctly expresses some of the advantages of case study research. The second selection goes into greater detail about the conceptual requirements for performing case study research.

Methods of Analysis  
Arild Underdal, 2002b

Through exploratory case studies we can trace policy-making and policy-implementation processes as they unfold and reconstruct the story behind each individual regime. Although heuristically guided by a more or less well-specified causal model, qualitative case-study research typically starts out with relatively open templates inviting exploration of whatever causal factors or mechanisms seem to be important in shaping developments. This makes the approach well suited for identifying causal mechanisms and pathways, for generating new hypotheses, and for exploring complex and unfamiliar puzzles. ... [C]ase-study authors should pursue causal paths wherever they might lead—also when they point to factors or mechanisms that are neither included in nor consistent with [previously outlined models]. Moreover, by virtue of their diachronic perspective, case studies are uniquely suited for studying *intra*regime dynamics—including specific phenomena such as learning and momentum, as well as more general but elusive mechanisms such as path dependency. Finally, they also provide unique opportunities for what might be called holistic analysis, which emphasizes the significance of interplay and context.

Case Studies of the Effectiveness of International Environmental Regimes  
S. Andersen and J. Wettestad, 2004

**“Textbook Ideals”: A Brief Summary of Some Principal Challenges.**

In this section we will briefly address certain principal challenges confronted by every researcher entering the complex terrain of regime effectiveness. The first challenge pertains to the issue of *case selection*. Careful selection can help us maximize what Bernauer and Mitchell (1998) call "internal" and "external validity." Internal validity involves making "within-case" causal relationships as plausible as possible. External validity has to do with the explicit identification of "the boundaries between the population of cases with which the findings can be validly generalized and beyond which valid generalizations are unlikely" (op. cit. p. 8). Since high internal validity can be seen as a necessary condition for high external validity, and since there is often a need for a trade-off between these ideals, much can be said for letting internal validity take precedence over external validity. How, then, are cases to be selected in order that internal validity be maximized? Some general principles can be outlined: first, one should focus initially on the theory and select empirical cases later. This will contribute to a reduced risk of achieving biased results. Second, look for cases where the values of the independent variable(s) vary, and third, look for more cases than explanatory variables. This makes it easier to hold specific, exogenous (control) variables constant and generally enhances analytical oversight and control. A fourth important recommendation is to try to find particularly "difficult" or "easy" cases in which the control variables either make it very unlikely or very likely that the explanatory variable will produce the theoretically predicted value of the dependent variable. . .

In addition to selecting cases and key variables, a second principal challenge pertains to *operationalisation and data gathering*. A ground rule here is to record and report explicitly and openly the process by which data is generated in order to make data and analysis as replicable as possible. Variables should be defined and operationalized so that the data relate to the theoretical constructs as accurately as possible. However, because appropriate, reliable and observable indicators of complex conceptual variables often prove difficult to find, and this is certainly the case in the regime effectiveness field, it is often necessary to identify various indicators and multiple proxies. In order to give such indicators substance, various types of data should be collected and utilized. . .

A final methodological challenge refers to *the unit of analysis*. Studies of the effectiveness of international regimes will easily zoom in on how individual regimes deal with individual problems. Understanding this is a tall order in itself. However, as environmental problems are often interrelated in intricate ways, and policies adopted in one regime context affect policy-making in other regime contexts, a narrow one-regime – one-problem focus may easily lead us to ignore important questions of interplay, context and linkages. (Young, 1999b, Stokke, 2000) ...

### **3.2 Process tracing**

Sometimes referred to as thick description or thick case studies, process tracing is in some respects a specific subset of case study research. It is characterized by intensive, detailed focus on one case (or perhaps a very few cases), with the purpose of delineating the causal pathways that led to an outcome.

Designing Social Inquiry: Scientific Inference in Qualitative Research  
Gary King, Robert O. Keohane, and Sidney Verba, 1994 (footnotes omitted)

Often a hypothesis or theory about political units implies a hypothesis or theory about the process by which the particular outcome observed at the level of the unit comes about; in particular, the hypothesis at the level of the unit may imply hypotheses about attitudes and behaviors at the level of individuals living within those units. These can then be tested using data on individuals. If we move to the level of the individual, we might focus on psychological variables or on aspects of individual experience or status, variables that make no sense if applied to political units.

...

Studies that rely on cultural explanations of political phenomena often depend on such analyses at the individual level. . . This means that acquiring more observable implications of a theory from units at a lower level of aggregation can also be applied to analyses of decisions. George and McKeown refer to an approach called “process tracing” in which the researcher looks closely at “the decision process by which various initial conditions are translated into outcomes” (George and McKeown, 1985:35). Instead of treating the ultimate outcome (for example, of an international crisis) as the dependent variable, new dependent variables are constructed: for instance, each decision in a sequence, or each set of measurable perceptions by decision-makers of others’ actions and intentions, becomes a new variable. This approach often reaches the level of the individual actor. A theory that links initial conditions to outcomes will often imply a particular set of motivations or perceptions on the part of these actors. Process tracing will then involve searching for evidence—evidence consistent with the overall causal theory—about the decisional process by which the outcome was produced. This procedure may mean interviewing actors or reading their written record as to the reasons for their action. . .

From our perspective, process tracing and other approaches to the elaboration of causal mechanisms increase the number of theoretically relevant observations. . . By providing more observations relevant to the implications of a theory, such a method can help to overcome the dilemmas of small-*n* research . . . Within each sequence of events, process tracing yields many observations. Within each political unit, analysis of individual attitudes or behaviors produce many observations. Furthermore, the investigator controls for those variables that apply to all observations because they pertain to the sequence of events of the unit as a whole. A focus limited to the ultimate outcome usually would restrict the investigator to too few observations to resolve the dilemma of encountering either omitted variable bias or indeterminacy. By examining multiple observations about

individual attitudes or behaviors, the investigator may be able to assess which causal mechanisms are activated. . .

### 3.3 Counterfactuals

#### Counterfactuals and Hypothesis Testing in Political Science

James D. Fearon, 1991 (footnotes omitted)

[Counterfactuals are] propositions that take the generic form “If it had been the case that C (or not C), it would have been the case that E (or not E).” Counterfactuals make claims about events that did not actually occur. It is argued in this paper that such propositions play a necessary and fundamental, if often implicit and underdeveloped, role in the efforts of political scientists to assess their hypotheses about the causes of the phenomena they study. Particularly in small-N research designs, scholars in comparative politics and international relations routinely evaluate causal hypotheses by discussing or simply referring to *counterfactual cases* in which a hypothesized causal factor is supposed to have been absent. . . .

Counterfactuals and the counterfactual strategy of hypothesis testing play an important but often unacknowledged and underdeveloped role in the efforts of political scientists to assess causal hypotheses. I have tried to show that any *nonexperimental* research that makes causal claims, be it of the large-N or small-N variety, must confront counterfactuals in the form of key assumptions or in the use of hypothetical comparison cases. Particularly in small-N research, the common condition of too many variables and too few cases makes counterfactual thought experiments a necessary means for serious justification of causal claims. I close with two simple suggestions for analysts evaluating causal claims via counterfactual argument rather than via regularities of association in a sample of actual cases.

First, small-N analysts could strengthen (or simply specify) their causal arguments by being *explicit* about the counterfactual scenarios need to support their hypotheses. Quite commonly, researchers in comparative politics and international relations assert that their dependent variable is X, where X is some *particular* event or phenomenon. X might be the failure of the U.S. to play the role of international hegemon between the world wars, a change in the nuclear proliferation regime, the dominance of the Liberal Democratic Party in Japan, or the collapse of communism in Eastern Europe. Analysts explaining such events need to understand that *none* of these are variables. They become *values* of variables if alternative, counterfactual scenarios are identified or if actual cases, some of which differ in outcome, are added to the analysis. If, for whatever reason, one is reluctant to add actual cases, then it is essential to make explicit what might have happened if a possible cause had varied. Counterfactual comparison cases need not be exhaustively detailed—just specified—so the reader knows what variation the theory or hypothesis proposes to explain.

The second key step is making inferences drawn from a counterfactual comparison *defensible*. Sometimes the argument implied by a counterfactual proposition is quite obvious and requires little or no unpacking. Other times, particularly when the hypothesis is evaluated against other hypotheses, analysts should make clear what arguments support it and how they do so. The analyst needs to ask whether the causal inference does indeed follow from the theories and historical facts used to sketch the comparison case and then, whether the counterfactual proposition is cotenable with the counterfactual scenario. Cotenable requires that if the counterfactual assertion had

been true..., nothing else would also have been different in a way that would have materially affected the outcome.

Of course, we can never be certain about what else would have been different if C had been different. But perhaps we can venture arguments that can be judged more credible or less credible, depending on our use of historical detail and theories about the way people behave. I should emphasize that I am not suggesting that there can be a special methodology for determining precisely what would have happened. Nor am I advocating a new methodology to rival established approaches to hypothesis testing. Rather, the intent has been, first, to show that counterfactuals cannot be avoided in nonexperimental hypothesis testing, then, to explicate their roles, and finally, to recommend that when political scientists use counterfactuals, they do so explicitly and carefully.

### 3.4 Qualitative Comparative Analysis

#### Boolean Analysis, Mechanisms, and the Study of Regime Effectiveness

Olav Schram Stokke

... I argue that one way to enhance cumulation of knowledge here is to narrow in on the causal processes, or mechanisms, invoked in such studies and investigate comparatively the conditions under which they succeed in changing problem-related behavior. A set-theoretic comparative technique developed by Charles Ragin, Qualitative Comparative Analysis (QCA), seems particularly well suited for this purpose because it permits analytical reduction even when the number of cases is too small to carry statistical analysis. The emphasis here is on the Boolean, or crisp-set version of QCA, with some discussion of the more recent extension to fuzzy sets.

... A frequently articulated complaint about case-oriented research, however, is that it tends to incorporate too much of the specific context of the case into the causal accounts to permit inferences to other cases: it tends to be weak on external validity. Others question the internal validity as well, arguing that case studies are often “over-determined” in the sense that the researcher is unable to choose between various possible or plausible explanations. In variable-oriented research, this is coined a degree-of-freedom or “small-N” problem—there are too few observations relative to the set of variables under consideration to determine the relative significance of the causal factors.

..

The QCA technique is Ragin’s response to the latter challenge. The original, crisp-set version builds upon the binary language developed by George Boole in the mid-1800s, which also forms the mathematical basis of computer technology. Boolean algebra does not manipulate numbers but rather systematizes logical expressions in order to sort data and create a list of the configurations of circumstances associated with a given outcome. The systematic formalization inherent in QCA helps overcome two limitations of the *logical* analysis of causality that was elaborated by Boole’s contemporary, John Stuart Mill. Specifically, the logical operations involved in Mill’s methods of agreement and difference become (1) increasingly complicated when the number of cases or variables grows beyond a handful, and (2) in practice, invalidated in situations of multiple or conjunctural causation, i.e., when recurrent events may be caused by *any* of several circumstances or *combinations* of circumstances. Boolean algebra permits careful inspection of such configurations even when the number of cases is high; and this ability is particularly important in case-oriented research which is much less inclined than variable-oriented research to address the effect of each causal condition in isolation. . .

The original formulation of QCA uses crisp (or Boolean) sets, implying that cases are either inside or outside a given category. For instance, when coding a fisheries management regime with respect to transparency of decision-making—a factor widely held to be relevant to regime effectiveness—the only values available would be presence and absence. More recently, the technique has been extended to fuzzy sets which permit differentiation among cases with regard to their degree of membership in such categories. To illustrate, a management regime which allows non-governmental organizations to participate as observers at regulatory meetings is more transparent than one which only publishes *post facto* reports—although none of them can be described as non-transparent.

The first step of a QCA analysis is to determine the set of cases to be included, [by building] a *truth table*, an ordering device which on the one hand lists all possible combinations of the causal conditions believed to be salient—the property space—and, on the other hand, variation in outcome among empirically observed combinations. The distribution of cases on the truth table can be used to evaluate the appropriateness of the initial model. If the model fails to align cases in reasonably comparable groupings, such heterogeneity may provide clues to refinement of the causal model. . .

The next step is to use the truth table to evaluate propositions about necessary and sufficient conditions for the phenomenon that is studied. Factors which are either present or absent for *all* cases with a given outcome may, if corroborated by other knowledge, be relevant to claims about necessary conditions for that outcome. . .

A final step supported by QCA is the introduction of *simplifying assumptions* whenever the analysis is impeded by limited diversity. Limited diversity refers to insufficient variation in the causal variables included... In such situations, the researcher cannot know how the non-existing cases would have influenced the necessity or sufficiency tests of causal configurations sketched above. . .

### **Conclusions**

. . . QCA permits analytical reduction, or simplification, of the data without ceding on the view that comparison must proceed configuratively—even when the number of cases is fairly low.

In the *model development stage*, QCA and variable-oriented competitors like structured and focused comparison and statistical inference all rely upon received theoretical and substantive knowledge. If an important difference exists, it would be that the QCA procedure explicitly compels the researcher to re-examine the model in the process of constituting cases. . .

It is during the stage of *data analysis*, however, that the distinction between variable-oriented analyses and QCA is the sharpest. The ability of the latter to capture causal conjunctions, even in small-to-intermediate-N situations, is an important edge over statistical inference. . .

Worth restating here is that two severe limitations of Boolean QCA, i.e. that variables must be dichotomous and that the analysis makes no allowance for measurement error and non-modeled causality, are lifted in the fuzzy-set version of QCA. So far, too few comparative studies have applied the fuzzy-set version to determine whether it will strengthen QCA's claim to the methodological middle ground between qualitative and quantitative analysis—but the potential is clearly there. Multiple-value variables permit more refined case characterization and may render QCA analysis more attractive to scholars inclined to in-depth narrative studies of one or a few cases. At the same time,

introduction of probability reduces the contrast between QCA and quantitative approaches to causal inference.

### 3.5 Quantitative statistics

#### A Quantitative Approach to Evaluating International Environmental Regimes

Ronald B. Mitchell (footnotes omitted)

##### **Introduction**

To date, quantitative analysis has been largely absent from efforts to study the effects of international environmental regimes. Yet, applying statistical procedures to relatively large sets of quantified data offers rich opportunities to address questions central to this research program. Quantitative analysis allows us to answer questions that either cannot be or usually are not answered by other methodologies as well as to reexamine (and buttress or refute) answers to questions already addressed by other methodologies. Quantitative techniques that use careful modeling and appropriate data could shed light on which features of a regime are responsible for a regime's success and which are superfluous, whether the effectiveness of a particular type of regime is problem-contingent, and how a regime's effectiveness varies with international and domestic contexts. Thus, quantitative analysis offers a valuable complement to qualitative techniques in evaluating the determinants of regime effects and effectiveness.

. . . [E]xisting case studies of environmental regime effectiveness as well as future ones face inherent problems of generalizability. Even commendable recent efforts to draw conclusions across multiple regimes, each analyzed by a different scholar, face difficulties in ensuring convincing comparability across regimes. Carefully designed case studies often generate compelling findings that fit the case studied quite well but usually do so by sacrificing the ability to map those findings convincingly to many, if any, other cases.

Quantitative analysis involves an opposite trade-off. Quantitative analysis can identify general propositions that hold reasonably well across a range of cases, even as they fail to explain any particular case well. . . They help us move from statements of possibility to statements of probability. . . Quantitative techniques offer the promise of replacing claims that "this strategy worked in this historical case" with more convincing policy-relevant and contingent prescriptions of which strategy is likely to work best to address a given problem under given conditions. . . .

##### **Definitions**

Recent work on qualitative methodology in general and counterfactuals in particular reminds us that any attempt to make causal claims requires comparing at least two cases. Here I clarify some terms useful for discussing quantitative study design, generally avoiding the term "case" because of its multiple, often widely divergent, meanings. *Units of analysis* are the entities or phenomena about which the researcher collects data. Units of analysis, often called cases, are a sample from a population or class of all conceptually-similar units that could have been studied. *Variables* are the dimensions, characteristics, or parameters of these units of analysis, with any variable having at least two possible *values*. Quantitative studies seek to evaluate the relationships among the values of variables. Dependent variables (DVs) are those whose variation we seek to explain. Explanatory or independent variables (IVs) are those whose variation we look to as possible explanations of the variation in the DV, based on theoretical claims regarding their causal influence on that DV. Control variables (CVs) are IVs believed to influence the DV that are included in an analysis in order to separate their influence on the DV from

that of the primary IV of interest. To avoid confusion, I distinguish between a unit of analysis and an observation. An *observation* is one set (or vector) of the observed values of all variables (IVs, CVs, and DV) for a given unit of analysis. ...

### **The Contributions and Limitations of Quantitative Analysis**

Case-studies have provided considerable evidence that certain regimes have influenced behavior. Indeed, a fairly extensive list now exists of regimes deemed effective or ineffective by thoughtful, well-informed scholars. A quantitative approach, however, allows us to answer more comparative questions that are central to the regime consequences research program but that have, as yet, gone unanswered. . .

#### *Quantitative Modeling to Compare Regime's Effects*

...

Before proceeding, some caveats and limitations of quantitative analysis deserve mention. First, as already noted, quantitative analysis trades off accuracy for generalizability. Including more units of analysis and more observations means doing so with less knowledge and detail. . . Claims from quantitative analysis, even if convincing, may be too probabilistic or vague for the desired purposes. Third, systematic and careful specification of variables and models can capture the presence or absence, strength, or quality of even quite subjective assessments of institutional and contextual features. But, the quantitative analyst must choose between capturing empirical richness by including and coding variables for a myriad of distinguishing features or using coarser coding schemes with corresponding simplification. Such simplifying of complex phenomena, by definition, ignores nuance and makes accurate mapping of findings to a given regime (internal validity) less compelling than their mapping to a large set of regimes (external validity).

### **Choosing Sample Size and the Unit of Analysis**

Before describing how to quantitatively analyze regime effects and effectiveness, we must ask whether such an analysis is possible. Quantitative analysis requires that the analyst have multiple and comparable observations. Most statistical techniques require at least as many observations (remember the definitions above) as independent and control variables. . . . If we assume that producing a reasonable regression model of any DV of interest involves 5 to 10 IVs, this suggests that we need data sets of at least 50 and preferably a few hundred observations including observations from a range of different units of analysis.

This simple calculation seems to confirm the common assumption that quantitative analysis is not possible because there are too few environmental regimes to compare. . . However, quantitative analysis can become possible and appropriate if we increase the number of observations by one of three methods, each already alluded to: examining "subregimes" rather than regimes, observing multiple years rather than one year before and one year after regime formation, and observing individual countries rather than all states as a group. . .

### **Conducting the Empirical Analysis**

...

#### *Availability of Data*

...

Other regimes we want to evaluate, however, will have no data, data for only a few years or a few countries, or data of such poor quality that it would make little sense to use it. What can we do in such situations? The obvious answer is to recognize the inability to

analyze such regimes in the short term and attempt to establish data collection systems that will allow such analysis in the future. An alternative possibility, however, involves a more careful and iterative search for data by identifying indicators relevant to the effectiveness of a given subregime and determining whether they are available and, reciprocally, identifying available data sets and determining to which subregimes they might be relevant. Such a process may uncover nonobvious variables that are both relevant and available to support the use of quantitative analysis to evaluate regimes. . .

### **3.6 Meta-analysis**

Meta-analysis is a technique for analyzing the results of separate but related studies on a particular subject. It is literally an analysis of the analyses, allowing a researcher to synthesize the results of many studies to get a clearer cumulative picture of research findings. Hunter and Schmidt (1990) describe it as “the quantitative cumulation and analysis of effect sizes and other descriptive statistics across studies.” It thus is a powerful tool in fields where there is a large universe of cases that bear on the same (or sufficiently similar) research question, a situation found throughout much of the behavioral and social sciences. However, one of the realities that currently limits the utility of meta-analysis in research on environmental compliance and enforcement is the relatively small number of cases that exist in the research literature to this point. Since meta-analysis must rely on extensive prior research, it will become a more important technique as the primary ECE research literature grows.

#### Methods of Meta-Analysis

John E. Hunter and Frank L. Schmidt, 1990

#### **Summary of Psychometric Meta-Analysis**

The goal of research in any area is the production of an integrated statement of the findings of the many pieces of research done in that area. In a broad sense, this means a theoretical analysis of how the many facts fit together. However, this broad theoretical integration cannot be put on a sound footing until a narrower integration of the literature has taken place. ...

Consider a theoretical question such as, “Does job satisfaction increase organizational commitment?” Before we can answer such a question, we must consider the more mundane question, “Is there a correlation between satisfaction and commitment?” Such questions cannot be answered in any one empirical study. Few social scientists have the resources to do the large-sample studies required to obtain the necessary population statistics. Results must be pooled across studies to eliminate sampling error. Furthermore, the correlation between satisfaction and commitment might vary across studies. ...

Meta-analysis begins with a set of all studies that an investigator has found that provide empirical evidence that bears on some particular fact such as the relationship between organizational commitment and job satisfaction. The key findings of each study are expressed in a common statistic, such as the correlation between commitment and satisfaction..., which measures the difference between experimental and control groups for the treatment of interest. Each such statistic can be examined across studies. The mean value of the statistic across studies is a good estimate of the mean attenuated population value across studies. However, the variance across studies is greatly inflated by sampling error. Thus, the first task in meta-analysis is to correct the observed variance across studies to eliminate the effect of sampling error. Then, the mean and

variance of population values are corrected for the effect of error of measurement and range variation. ...

If there are large differences between studies, then moderator variables are usually not hard to find. ... Meta-analysis provides a method for establishing the relevance of a potential moderator variable. The moderator variable is used to split the studies into subsets, and meta-analysis is then applied to each subset separately. Mean differences will appear if a moderator is present. ...

... For meta-analysis, scope is an empirical question. If we have the resources for a wide scope, then meta-analysis can be used to assess the scope of the results. If meta-analysis shows only small differences over a very wide set of studies, then we have found that many moderator hypotheses are at most of only minor importance. If the wide-scope study shows large differences, then meta-analysis can be applied to subsets of studies with smaller scope. Meta-analysis then shows which were aspects of scope (i.e., moderators) are truly important and which were erroneously thought to be important. ...

A key point of consensus in meta-analysis is that restriction of scope should be topical rather than methodological. The worst reviews are those in which the author cites only "key" studies. ...

Many authors justify selective reviews on the basis of the "methodological deficiencies" in the studies not considered. However, the assertion of "deficiency" is usually based on a theory that is itself empirically untested. ... Meta-analysis provides an empirical procedure for the identification of methodological deficiencies if there are any. First, one should gather a comprehensive set of studies. Second, one should identify those believed to be "defective." Third, one should apply meta-analysis to all studies. If there is no variation across studies, then there is no difference between the "defective" studies and the "competent" studies. Fourth, if there is variation across all studies, then that variation may or may not be explained by separate meta-analyses of the "defective" and "nondefective" studies, the next analysis to be conducted.

### **3.7 Legal Research Methodologies**

An initial distinction must be made between legal research methodologies employed by practicing lawyers and those of legal scholars. Practitioners analyze discrete sets of laws and facts within the confines of a specific case. They have been slow to incorporate other disciplines, such as social science, and seem to lack any specific methodologies to analyze whether laws work. Legal scholars, by comparison, address issues ranging from theoretical to practical. They have shown more willingness to borrow from other disciplines, yet they still struggle to find a framework for evaluating the effectiveness of law. The following two sections look at how lawyers and legal scholars conduct research.

#### **3.7.1 Legal research for practicing lawyers**

Lawyers tend to be trained very narrowly – to think logically, to analyze written texts, to draw analogies from precedents, to apply a rule to a given set of facts, all on behalf of the narrow interest of a specific client. In other words, lawyers are generally taught how to practice law. Most legal research, therefore, aims to find legal "authority" that will aid in finding a solution to a legal problem.

Most first year law students in common law jurisdictions are taught to structure these arguments using the IRAC formula: **I**ssue – identify the legal issues raised by the facts presented; **R**ule – determine the governing law for the issues; **A**alysis – apply the rule to facts presented; and **C**onclusion – determine the outcome in the case.

When determining the applicable governing law, practitioners turn first to “primary sources”, such as laws, regulations, and published cases. They then consult “secondary sources”, or background resources, such as textbooks, journals, and case law digests.

Once this basic research is concluded, practitioners employ several basic approaches to legal reasoning in their analysis, the most common of which are discussed in the first excerpt below. The second excerpt briefly discusses how legal reasoning can differ in common law versus civil law systems.

The final excerpt in this section discusses the growing use of extra-legal sources in litigation. At one time, lawyers confined themselves to primary and secondary sources, but this began to change in the United States in the early 1900s when Louis Brandeis argued before the U.S. Supreme Court utilizing extra-legal sources such as medical and social science research. The final excerpt briefly reviews the “Brandeis brief” and its impact on modern legal practice.

### The Stages of Legal Reasoning: Formalism, Analogy, and Realism

Wilson Huhn (2003) (footnotes omitted)

#### I. Developmental Theory and the Three Stages Of Legal Reasoning

Law comprises both logic and morals. Legal decisions are deduced from rules of law, however, to induce obedience, these decisions must not only be logical but must also reflect the prevailing mores of society. Thus, legal reasoning inevitably attempts to meld the oft-conflicting strictures of logical rigor and moral justice. What we know of the development of logical and moral reasoning helps to explain how logic and morality are combined in legal reasoning.

...

#### A. The Definitions of Formalism, Analogy and Realism

...

##### 1. Formalism

Formalism is the application of an existing rule of law by its terms to a set of facts. Formalists attempt to resolve disputes by defining the terms of legal rules so as to include or exclude the facts of the case at hand. Formalist arguments are deductive in nature, and conform to the structure of a syllogism of deductive logic: the rule of law is the major premise, the facts of the case are the minor premise, and the legal result is the conclusion.

Most formalists favor textual forms of analysis, and rely particularly upon the "plain meaning" of the words of the legal text. This method of analysis aspires to discover an objective definition of the text. But formalism is not limited to textualism. Specific rules may be derived from examination of legislative intent, from specific traditions and even from policy arguments.

...

## 2. Reasoning by Analogy

One step removed from formalism is reasoning by analogy. Formalism, in law, is to apply a rule of law to a case because the facts of the case are the same as the terms of the rule. Reasoning by analogy, in contrast, is the application of a rule of law to a case because the facts of the case are similar to the terms of the rule. While formalism is scientific and grounded in logic, analogical reasoning is an art that is grounded in rhetoric.

...

To reason by analogy is to find similarities between the situation at hand and other known situations. In law, the most common form of analogical reasoning is the use of precedent. In common law jurisprudential systems like ours, court decisions are recognized as a valid source of law. When a previously decided case is discovered that is "on point," the rule of the previous case governs the case to be decided. Not infrequently, the previous case is not precisely on point with the case to be decided. In this circumstance, the court must decide whether the previous case is sufficiently analogous for its rule to govern the case to be decided. It also frequently happens that there is more than one case that arguably applies to the case at hand. In that circumstance, courts that reason by analogy must determine which of the previous cases is most similar to the case to be decided.

## 3. Realism

Legal realism, also called policy analysis, or practical reasoning. . . [i]t is an ends-means analysis that entails a judicial balancing of the costs and benefits of a legal outcome. Legal realism is a method of legal reasoning that determines what the law is, not by invoking categorical legal principles, but rather by considering the law's probable consequences. Law should be interpreted not by consulting a dictionary, but by inquiring into the underlying purposes of the law. The courts should not seek a literal definition of the terms of the law, but should rather seek to fulfill the values that the law is intended to serve. [Common policies employed by the realists include: equity, economic efficiency, and predictability in the judicial process.]

...

Symposium: Relationships Among Roman Law, Common Law, and  
Modern Civil Law: Roman Law, Common Law, and Modern Civil Law  
Peter G. Stein (1992) (footnotes omitted)

...

Civil-law reasoning may loosely be described as deductive reasoning, by which one proceeds from a broad principle, expressed in general terms, then considers the facts of the particular case and finally, as in a syllogism, applies the principle to the facts so as to reach a conclusion. This form of reasoning leads the civil-law lawyer to present a legal argument as if there can be only one right answer to any legal problem, and disagreement on the application of the law to the facts of a case must, in this way of thinking, be the result of faulty logic by somebody. Thus, civil-law judges in general do not give dissenting opinions and every judgment, even in appellate cases, is that of the court as a whole.

In the common law no formulation of a rule, whether by judge or academic, is final. A later judge can broaden or narrow the terms in which it is expressed. What is

authoritative is not what is said but what is decided, and the difficulties of discovering what rule a particular decision has laid down are well known. The common law is thus open-ended in that new extensions to existing rules can be revealed at any time by the courts, but it has no existence as a body of material distinct from what the courts have decided. The common-law judge is the oracle of the law and takes personal responsibility for his decisions. If he dissents from his colleagues, it may be because he is ahead of them; today's dissenting opinion may be tomorrow's majority view. As a result of this prominence of the judges, academic lawyers in common-law countries have not enjoyed the same prestige as their colleagues in civil-law countries.

Traditionally the civil-law judge is a fungible person, one of a group of anonymous, almost colorless, individuals who hide their personality behind the collegiate responsibility of the court. Their duty is to apply the written law, and the meaning of that law is to be discovered from the writings of its academic exponents.

...

To the common-law lawyer the civil-law type of deductive logic seems to reverse the natural form of legal reasoning. The common-law lawyer begins his argument with an examination of the facts, with a view to identifying the precise legal issue raised by the case. When the relevant rules are derived from earlier cases cited as precedents, each party cites those precedents that favor his own position and emphasizes the facts of his case relevant to those precedents. They are then analyzed with a view to establishing which are the most significant precedents. At this point in the debate, there is usually much scope for argument; the common law is therefore never presented, like the civil law, as a set of certain rules that can be applied with inexorable logic.

When a common-law lawyer asks what the case is about, he is thinking of the facts, with a view to identifying the material circumstances of the case and to showing that they fall within the scope of one rule rather than another. When a civil-law lawyer asks what the case is about, he generally refers to the legal issue defined in a general way. Often the adversarial procedure of the common law has the advantage of identifying the issue with greater precision. In the civil-law procedure the real points at issue may only emerge gradually as the case proceeds. ...

Teaching Appellate Advocacy: Supplementing the Pro Se Record with a Brandeis Brief  
Margaret Z. Johns, 2002 (citations omitted)

In addition to cases, statutes, procedural rules, and administrative regulations – the traditional sources of legal authority – courts may also turn to science, empirical studies, social and psychological theory, history and current events when developing a rule of law. ...

Indeed, at the turn of the twentieth century, Louis Brandeis established the value of turning to extra-legal sources when he submitted his brief supporting shorter work hours for women in *Muller v. Oregon*, 208 U.S. 412 (1908). In *Muller*, Louis Brandeis assembled a substantial body of medical and social science research documenting the debilitating effect on women of working long hours. He presented this material to the United States Supreme Court in his brief defending Oregon's limits on the number of hours women could work. In the decades since *Muller*, social science studies have continued to play a significant role in deciding major constitutional cases, particularly in the area of wage and hour law.

Moreover, some of the most significant and controversial cases of the twentieth century have relied on social science research. For example, in *Brown v. Board of Education*, 347 U.S. 483, 495 (1954), the Court held that segregation in public schools violated the Equal Protection Clause of the Fourteenth Amendment. In so holding, the Court relied on empirical studies to support its finding that segregation of African-Americans "generates a feeling of inferiority as to their status in the community that may affect their hearts and minds in a way unlikely ever to be undone." The Court, referring to the studies as "modern authority," cited them in a footnote, much as it would list case citations supporting a proposition of law.

Thus, empirical research, which in 1908 the Muller Court had said "may not be, technically speaking, authorities," had by 1954 in *Brown* come to be described, and used, as "modern authority." ...

In fact, Supreme Court justices have often used non-legal material, such as social science research, to establish or criticize a rule of law. For example, in considering whether a prayer at graduation violated the First Amendment, the Court relied on psychological studies supporting the "common assumption that adolescents are often susceptible to pressure from their peers towards conformity and that influence is strongest in matters of social convention." *Lee v. Weisman*, 505 U.S. 577, 593 (1992). In writing for the majority, Justice Kennedy relied on three psychological studies to support this proposition. ...

### **3.7.2 Legal scholarship**

Legal scholarship starts at its simplest level with those who have pulled together cases from a range of jurisdictions and compiled them into a treatise on a particular subject; this often involves something more akin to codification than to analysis. The more advanced legal scholarship involves analysis of legal questions.

What methodology is used for this legal scholarship, particularly for scholarship that tries to understand the impact of law? There is no single or simple answer to this question, but the final two excerpts provide some insight. The first excerpt below reviews the current state of empirical research in legal scholarship and argues for expanding the realm of legal scholarship. The second excerpt highlights the links that law has increasingly drawn to other disciplines (e.g., social sciences, cognitive psychology, economics, moral philosophy, natural sciences). Combined, they show that there is no real methodology in legal scholarship for identifying and evaluating the impact of law, but rather law must borrow methodologies from other disciplines. Accordingly, the methodologies used in much of the landmark scholarship in these "Law and" categories (e.g., Cass Sunstein, Richard Posner) often more resemble the methodologies of the "and" than of the "law". Legal scholars use historical research, economic analysis, game theory, social norm research, comparative analysis, and other methodologies to analyze different "legal" questions. Research on international law involves different sources – treaties, customary law (however that may be defined or created), state practice, etc. – but the methods of argument do not seem to be meaningfully different.

The Importance of Being Empirical  
Michael Heise (1999) (footnotes omitted)

*A. The (Relative) Dearth of Empirical Legal Scholarship*

...

A quick glance at the current production of legal scholarship will convince most readers that an empirical research [referring only to statistical techniques and analysis] presence within the academic literature is marginal, at best. While Professor Schuck's earlier observation that the two main forms of legal scholarship -- theoretical and doctrinal -- account for "almost the entire corpus of legal scholarship" remains largely accurate, it is especially accurate if one views legal scholarship in its entirety.

However, ... evidence suggests that the production of empirical legal scholarship is on the rise. This trend is particularly clear if one reviews only legal scholarship published during the past decade. Thus, the role of empirical legal research, inside and outside American law schools, grows, though in a somewhat halting manner.

*B. Some Consequences of This Dearth*

The dearth of empirically-moored legal scholarship has consequences, including some that law professors should not take lightly. Some commentators argue that legal scholarship's weak empirical mooring undermines efforts to make the legal system more accessible and efficient for people. Others suggest that an increase in empirical legal scholarship will help ease the growing rift separating legal scholarship from the legal profession. ... The development of good theories is made even more difficult without the benefit of good data. Likewise, the lack of an empirical footing poses a threat to legal theory's persuasiveness and influence.

Another argument for more empirical legal scholarship stems from theoretical scholarship's propensity for the normative. It is at least hoped that empirical scholarship can more easily separate the normative from the descriptive and better maintain neutrality. . . . Although purportedly "value free" empirical analyses can be generated to support almost any particular viewpoint, empirical methodologies, conventions, and norms make such efforts decidedly more difficult to mask. This is particularly true for a community of scholars that values and practices honorable peer-review and replication of work.

...

Common sense suggests that law professors should respond to the need for more empirical legal scholarship. Some scholars bluntly assert that if empirical legal research is to go forward legal scholars "must" help organize and participate in it, albeit with the aid, where necessary of interested scholars from other disciplines. ... To the extent that legal theory generates research questions and hypotheses amenable to empirical testing, those law professors generating legal theories are certainly well-positioned and informed to pursue the related empirical dimension.

Calls for more empirical data arrive at about the same time that commentators both inside and outside the legal academy note that trends in legal education point toward law schools' further integration with the larger university community. Presumably, law faculty who are engaged in empirical research activities -- as are many faculty in other academic departments and schools -- will be better positioned should legal education and scholarship continue to become more "university-like," as predicted. Moreover, if predictions that law schools will integrate further into the general academic and university community come true, the importance of incorporating broader methodologies

into legal scholarship becomes greater if, for no other reason, than to shore up its intellectual stature and reputation among the broader community of scholars.

### *C. Reasons for This Dearth*

Despite evidence that law professors recognize the need for more empirical legal scholarship, relatively little emerges from the nation's law schools. Various factors help explain this paradox . . .

#### 1. It Is Hard Work

Professor Friedman makes a crucial point bluntly and plainly: "Empirical research is hard work." Such a statement is not meant to imply, however, that non-empirical research is easy. Rather, the point is simply that empirical research projects typically force legal scholars to confront a unique set of obstacles, many of which stem from law schools' general and traditional orientation away from empirical research.

Many worthwhile empirical projects require access to data, specialized computer systems and software, as well as greater interaction with like-minded colleagues who are usually found in other university schools and departments.

#### 2. Lack of Training

... [M]ost law professors do not possess the requisite training or background that most sophisticated statistical work requires. Fewer still possess the inclination and energy to acquire, update, or retool their research skills or analytical repertoire. Empirical research projects, particularly those that employ higher-level statistical techniques, require more than the traditional legal reasoning and analytical skills that law schools impart to their students and law faculties.

To offset this gap in expertise, law professors could collaborate with other scholars who possess experience and expertise in empirical research. . . . Despite a tradition of scholarly collaboration in many other academic disciplines, law professors typically conduct their legal scholarship themselves.

#### 3. Exposure to Falsification Through Replication

Empirical research is far more amenable to falsification through subsequent efforts by others at replication, thereby making it a slightly riskier genre. Clearly, much of the theoretical work that fills law reviews involves scholars commenting upon, challenging, chiding, debunking, or disagreeing with prior work. But at one level, it is more difficult to falsify or disprove a theory than it is to falsify or challenge results from empirical work. Theorists can certainly persuade readers that one theory is better than another. This, however, is something quite different from empirically corroborating or casting doubt over a theory's efficacy or a study's results or conclusions. In this regard, numbers provide less shelter than words. ...

...

#### 4. Lack of Prestige

Many current leading scholars agree that empirical legal scholarship garners less prestige than its more theoretical counterpart. ... Thus, in order "to get the richest rewards available within the modern legal academic community a professor has to do

'theory'." The reason for this is not entirely clear, but the legal academy's tradition of favoring theoretical and, to a lesser extent, doctrinal legal scholarship surely is one factor contributing to the relative lack of empirical legal scholarship.

#### 5. Lack of Internal Institutional Incentives

... [M]any – perhaps even most – law schools possess incentive structures that were erected in eras that favored theoretical and doctrinal scholarship over empirical. The current internal incentive structure confronting many law professors interacts with the prestige variable, discussed above.

... With a well-worn path to tenure already cleared by a tradition of theoretical and doctrinal scholarly production and productivity, those who veer off this path and onto the less traveled path of empirical scholarly production assume some level of additional risk.

Compounding the risk posed by a potentially significant investment of time is uncertainty. Specifically, somewhat peculiar to empirical work is that, *ex ante*, researchers frequently do not know what the data might say until after the data have been gathered, coded, and analyzed. ...

Finally, few success stories exist that might serve as possible role models for younger law faculty. Because "law schools have not made empirical research a major part of the teaching or scholarly mission," success stories involving empirical research projects either at the institutional or individual level are difficult, although not impossible, to identify. ...

Paradoxically, the relative dearth of empirical legal scholarship generates one critical strategic advantage for young, untenured legal scholars. The underdevelopment in the field creates far greater opportunities for making an original contribution to legal scholarship. Given the abundance of thinking and writing in many areas of the law, such as constitutional law, it becomes increasingly difficult to find an underexamined scholarly corner of law to say something new. In contrast, the list of legal research questions that would benefit from empirical analysis already staggers and continues to grow.

#### 6. Lack of External Institutional Incentives

Empirical legal scholarship lacks sustained and consistent external funding support. Unlike many of the social sciences, and even more unlike the hard and physical sciences, law school funding is largely internal and frequently tuition-driven. ...

... The relatively small amount of external financial support for empirical legal research projects is yet another reason not to pursue such research. Moreover, the output of those willing to pursue a small slice of the research funding pie will be small. One less obvious consequence stemming from a lack of external financial support is the harm to data gathering. Because data gathering, which resides at the heart of much empirical work, is both a time-consuming and labor-intensive enterprise, it is also frequently expensive. Data production's relatively high costs and the relatively low investment in empirical legal research create a scarcity of data and datasets relevant to legal scholars. Without the benefit of data, even the less time-sensitive secondary analyses cannot proceed. The full extent of the harms to empirical research set into motion by underinvestment in data is difficult to gauge.

...

Law and Society & Law and Economics: Common Ground, Irreconcilable  
Differences, New Directions: Law and the Methodology of Law  
Edward L. Rubin (1997)

For the last few dark and stormy decades, ever since it irreversibly dismantled its formalist home, legal scholarship has been traipsing from door to door, looking for a methodological refuge. The doors at which it has knocked have included literature, philosophy, economics, political science, and sociology. ...

This article briefly canvasses the various efforts to link law to other disciplines, a process that has acquired the appropriately indeterminate name of "law and." It argues that legal scholarship adopts a unique stance toward its subject matter that precludes the direct application of another field's methodology. But because of its internal features, legal scholarship needs to rely on other methodologies, particularly social science, to provide an understanding of the forces that act upon the legal system and of the impact of legal decisions.

...

I. Law And

The primary concern of this discussion will be standard legal scholarship. This may be defined as work which frames recommendations, or prescriptions, to legal decision-makers. In some cases the work critiques an existing judicial decision, statute, regulation, or constitution, and the recommendation is simply that the decision-maker should act differently. Less commonly, it merely offers a recommendation, with no comment about an existing decision. Most often, the work combines a critique of an existing decision with a prescription, whether general or specific, for a different approach. And sometimes it even suggests that the decision-makers are doing exactly the right thing. All this work, however, is characterized by its normative quality and the direct engagement of its recommendations with identifiable legal decision-makers.

...

A. Legal Scholarship and Natural Science

...

[T]he discourse of natural science is essentially descriptive rather than prescriptive. It begins from the premise that there is a real world "out there," separate from conscious human control. ...

Legal scholarship differs from natural science in the prescriptive purpose it adopts. ... Modern legal scholars regard law as the product of conscious decision by public decision-makers, and possibly others. There is thus no fixed reality, but rather an ongoing process by which people in certain positions make decisions; in bald terms, law is created, not discovered. This sentiment has led to prescriptive efforts to improve the quality of those decisions according to the scholar's own views about law or public policy.

Another major contrast between legal and scientific scholarship is that the external information on which natural scientists rely consists of data, whereas the external information for legal scholars consists of events. The distinguishing characteristics of data, as opposed to events, is that they are generated, defined, and given significance by the academic discipline that studies them. ... Judicial decisions, legislative enactments, and administrative regulations, on the other hand, are neither discovered in law libraries nor unearthed in the field, but generated by nonacademic actors. In dealing with this external information, legal scholarship necessarily adopts a reactive approach.

Secondly, the nature of the discovered phenomenon in science is defined by the discipline, whether this definition consists of determining the discovery itself, like the subatomic particle; the boundaries of the discovery, like the chemical reaction; or the mere fact that it is new, like the dinosaur bone. Events, as opposed to data, come to a scholarly discipline prepackaged, either by their human originator or by a pattern of human observations that is much broader than the one that the discipline establishes.

...

A final difference between the law and natural science lies in the noncumulative quality of legal scholarship. ... What underlies the cumulation of scientific knowledge is a unified theory of causality. Scientists are not only involved in a descriptive enterprise, but they are in agreement that their enterprise involves an effort to explain the causes of observed phenomena. They further agree about the sorts of statements that will count as explanations. Viewed from this perspective, natural science is not a group of disciplines, but a single discipline with a broad range of topics. ...

#### B. Legal Scholarship and Literary Criticism

Another source of methodological assistance for legal scholarship is literary criticism, in many ways the diametric opposite of natural science. "Law and literature" ... now constitutes an important theme in modern jurisprudence. ... Both literary critics and legal scholars can be properly regarded as engaged in a process of interpretation, an effort to discover the meaning of a preexisting text. This interpretive process may attempt to discern the intent of the author, but that is only one approach to legal or literary meaning; there are numerous others, such as assessing the text's effect upon the reader, or its range of possible meanings, or its interaction with a broader set of social attitudes. All these approaches seem common to both legal scholarship and literary criticism, and have produced a body of writing that can be described, in both cases, as largely reactive and largely noncumulative. Their starting points are works that are generated outside the discipline, and whose character and boundaries are defined by their human originators. Their products are noncumulative, although they rely upon a general background of knowledge and sensibility. The task that both groups of scholars set themselves is to evaluate, rather than to explain; they possess no theory of causality and generate no statements that can be verified or falsified by empirical means.

... [T]here remains a basic difference in the purpose of these academic fields, a difference in the scholar's stance toward her subject matter. Literary criticism adopts an essentially nonprescriptive stance. The critic does not address the author with instructions on how to create more realistic characters or construct a better plot, the way the legal scholar instructs judges how to interpret precedent, use social policy, and reason through to their conclusions.

...

#### C. Legal Scholarship and Moral Philosophy

...

Most moral philosophers ... see themselves as engaged in a normative enterprise, as legal scholars do. As such, they are necessarily involved with their subject matter; they assert, and indeed insist, that ethical systems affect human life, and their own efforts are intended to affect the formulation of those systems. Sometimes, their writings are addressed to individuals, and sometimes specifically to public decision-makers, suggesting to them how to think, how to live, and how to act. Philosophers evince no particular respect toward their subject matter, whether that subject matter is the world,

the soul, or other philosophers. Their general attitude, instead, is one of critical inquiry, a refusal to take things on faith or to defer to the genius of one's predecessors.

Many philosophical ideas are quite useful in the normative debates that constitute the essence of standard legal scholarship; this phenomenon is hardly surprising, since these ideas are general ones, intended to apply to all forms of knowledge and argument. But the particular methodology of moral philosophy cannot be readily assimilated by legal scholarship; while both fields are normative, the type of normativity involved is rather different. To follow Kant's distinction, most moral philosophy is phrased categorically, rather than contingently - the question is how one should behave, not how one should behave if one wants to achieve a particular objective. Legal scholarship generally has some contingent objective at its source, some set of accepted purposes on which its prescriptions are based. . . .

Apart from the different quality of its normative stance, philosophy is distinguished from law by its nonreactive quality, its ability to set its own agenda. Philosophy certainly responds to broad-based changes in the intellectual climate of society, but so does everything else; its focus on the underlying nature and significance of events precludes more direct influence. ...

The one trait that moral philosophy does share with legal scholarship is its lack of cumulation. Philosophic problems rarely become settled . . .

#### D. Legal Scholarship and Social Science

A final source of methodology for legal scholarship, and by far the most commonly invoked, is social science. ...

With respect to prescriptiveness, social science exhibits a considerable range. Sometimes social scientists, consistent with their aspiration to be scientists, take an entirely descriptive stance, treating their subject matter as a fixed phenomenon, "out there" beyond the control of rational decision-makers. ... At other times, social scientists assume an interpretive position toward their subject matter, trying to reconstruct its meaning the way literary critics reconstruct a text. This is generally thought to involve participation in the conceptual and normative framework of their subjects - an active understanding of the way the people who are being studied create meaning for themselves. At still other times, however, social scientists frame contingent prescriptions, addressed to particular decision-makers; they recommend monetarist policies to the Federal Reserve because they increase wealth, or design some form of oversight for Congress that can control administrative misbehavior. Such prescriptions are contingent because they rely on an underlying objective - that wealth should be increased, or administrative behavior should be subject to control.

Although the complexity of the social science enterprise precludes easy characterization, its dominant approach appears to be descriptive, thus distinguishing it from legal scholarship. Ever since its inception, social science has aspired to describe social phenomena and explain their causes. ...

The reactivity of social science displays a range that is similar to its range of prescriptive attitudes. At one limit, social science can be as nonreactive, or independent, as natural science, treating external phenomena as a body of data to be discovered, defined, and evaluated. This is typical of fields that deal with individual behavior, such as psychology, sociology and microeconomics. As the focus of a discipline moves toward collective

behavior, it is likely to become more reactive, allowing external phenomena to assume the character of events. Thus, historians react to social upheavals, political scientists react to elections, and macroeconomists react to depressions. In all these cases, however, the reaction is tempered by an independent research program that can be brought to bear on the event in question. ... In short, although social science varies greatly in its quality of reactivity, it does not seem to be as reactive as legal scholarship.

The pattern of cumulative knowledge in social science is also complex. ... In other words, while all the natural sciences comprise a single discipline, divided into categories only on the basis of their subject matter, every social science field actually consists of multiple disciplines, which share the same subject matter but employ different modes of explanation. Cumulation does occur, but only within each separate school of thought.

...  
Social science is also cumulative in that it has developed a variety of means for the verification or falsification of its hypotheses: structured observation, statistical survey data, laboratory experiments, simulations, and mathematical models are all employed to garner general acceptance for social science propositions. To be sure, the results obtained have not achieved such acceptance, but the really trenchant criticisms are generally directed toward the underlying theory of causality, rather than the method of verification.

For the most part, legal scholarship does not display even the fractured cumulativity of the social sciences. It does not divide into subdisciplines whose participants are able to agree upon a theory of causality and a method of verification. Rather, it tends to divide among a variety of normative positions that do not bear any obvious relationship to one another. A feature of recent decades - that is, of the "law and" era - is that many of these positions tend to become linked, or hard-wired, into a particular methodology, for no apparent epistemological reason. Thus, political conservatives have become linked to economics; political progressives to deconstruction, or what Pauline Rosenau calls skeptical postmodernism; race or gender-oriented progressives to constructive postmodernism; political moderates to interpretivism or law and literature. With the exception of law and economics, where one can rely on a rather crisply articulated social science methodology, these separate positions generally do not develop cumulative traditions. They have, however, made normative debate among those with differing affiliations more difficult to sustain.

## II. The Methodology of Law

### ... C. The Use of Social Science in Legal Discourse

Combining the separate discourse of legal scholarship, the reactive and involved nature of that discourse, and the recognition that the discourse cannot function autonomously, leads to a fairly obvious conclusion: legal scholarship must rely on other disciplines to characterize external events and effects, although it must continue to develop its own methodology for framing its characteristic prescriptions to legal decision-makers. The separate methodology of law is essential, but it is a relatively thin one because of its reactivity and involvement. Thus the "law and" question is crucial, and the recent efforts of legal scholars in shopping among other disciplines has not been misplaced. What is being sought, however, cannot be a methodology for legal scholarship itself, for no other discipline addresses the same issues and adopts the same stance toward them. Rather, the real promise of the "law and" enterprise is that it can provide the characterization of events and effects that legal scholarship is lacking and can no longer aspire to develop.

The crucial question for interdisciplinary legal scholarship, therefore, becomes the simplest one. Other disciplines should not be canvassed for their methodology, but for their subject matter. ...

This model of law's relationship to social science tracks Weber's model of society in general. Weber distinguished between value rationality (the debate about desirable social norms) and instrumental rationality (the search for the optimal means, as empirically determined) to achieve a predefined end. He believed that instrumental rationality should serve the purposes determined by value rationality. Indeed, being instrumental, it must serve some purpose that is defined by another mode of discourse, and we would be irrational to take it as an end in itself. Weber was concerned that instrumental rationality - the discourse of technology and bureaucracy - would become so dominant a mode of thought that it would preclude or obscure normative inquiry and thus engender this irrationality. In legal scholarship - not surprisingly, for the subject matter of law and social science overlaps - the relationships are the same. The essence of the field is the structured debate about social norms, or value rationality in Weber's terms. Social science is an instrument that enables law to achieve those purposes that this normative debate defines in the most instrumental or empirically valid manner. As such, it has an extremely valid role to play, but should not - it cannot rationally - be taken to resolve the debate about the proper choice of purpose. Thus, social science plays an essential but subordinate role in legal scholarship. ...

## **4 TOOLS FOR APPLYING USABLE KNOWLEDGE**

This section discusses some potential tools for moving beyond research methodologies into design and planning principles. We want research to arm us with what Oran Young has termed "usable knowledge," a level of understanding that lets us design institutions and plan for the future. On some level these tools are the practitioners' analog to the researchers' methodologies, as they are frameworks which help us organize information and generate insights into how to design ECE systems.

### **4.1 Diagnostic tools for designing institutions**

Usable Knowledge: Designing Institutions for Social Ecological Systems  
Oran Young, forthcoming

#### **The Diagnostic Approach to Institutional Design**

...

So far, our knowledge of the roles that social institutions play as determinants of the dynamics of human-dominated ecosystems is limited; the need for more research to enhance our understanding of such matters is great (Young et al. 1999/2005). Still, we have learned a lot about the nature of institutions and the roles they play in the dynamics of social-ecological systems. What has emerged from our efforts to bring this knowledge to bear in addressing specific problems in this field over the last ten years is a two-step procedure that starts with a stage of diagnosis and then - and only then - goes forward to a more prescriptive stage featuring the development and implementation of recommendations relating to the (re)formation of effective environmental and resource regimes (Young 2002). What this means is that it is essential in coming to terms with specific situations to begin with an effort to characterize key features of the problem at hand as clearly and sharply as possible. Only then can we expect to be in a position to

determine the nature of the institutional arrangements needed to help in mitigating the problem under consideration or in finding ways to adapt to its major consequences. . .

### **Problems**

The problems arising in human-environment interactions come in many forms. The diagnostic approach therefore starts with an assessment of the major features of the problem at hand and proceeds to assess the implications of these characteristics for the nature of the regime needed to solve – or at least ameliorate – it.

**1. Does the problem take the form of a coordination problem or a cooperation problem?** Coordination problems, such as the need to develop shipping lanes to guide maritime transport, lend themselves to solutions that do not generate incentives to cheat on the part of individual actors. By contrast, cooperation problems, such as the need to devise rules governing the behavior of harvesters in a fishery, call for the development of mechanisms to deter violations on the part of individual actors . . .

**2. Is a one-off solution feasible or is it necessary to find ways to address the problem on an ongoing basis?** Sometimes it is possible to make use of irreversible measures to solve a problem. Once an oil tanker is designed and built to comply with rules requiring the installation of segregated ballast tanks, for example, the problem is solved in the sense that there is no way for operators to eliminate or disable these tanks. . .

**4. Is the problem cumulative or systemic?** Some problems, such as the loss of biological diversity, are cumulative in the sense that they are place-based, recur in many different settings, and must be tackled piecemeal or, in other words, in one setting at a time. Others, such as climate change, are systemic in the sense that they occur at a global level and must be dealt with in holistic terms. . .

### **Subjects**

Regardless of the character of the problem, the diagnostic approach also directs attention to a number of matters relating to a regime's subjects, both individually and collectively. Insights regarding such matters may have far-reaching implications for the nature of the regime required to solve or ameliorate a problem.

**7. Do the subjects behave as rational actors – in the sense of being self-interested utility maximizers - or do their actions reflect other sources of behavior, including a sense of shame or the force of habit?** . . . most actors are influenced, at least in part, by normative commitments or by the force of habit (March and Olsen 1998). In such cases, finding ways to internalize the rules and, in the process, to turn compliance into an automatic response emerges as a central concern. ...

**10. Is the group of subjects homogeneous or heterogeneous?** In some cases, it is reasonable to treat the group of subjects as homogeneous, a situation that makes it feasible to create compliance mechanisms that treat them in a uniform manner. . . But more often than not, a regime's subjects will differ from one another in important ways. . .

### **Rules**

There is often room for disagreement about the best way to frame a problem, a fact that sometimes gives rise to hard bargaining. But however a problem is defined and whatever the consequences for the regime created to cope with it, issues of implementation arise as soon as the regime becomes operational. In this context, the formulation of rules emerges as a third cluster of issues calling for diagnostic attention in designing regimes to address specific problems.

**11. Do the rules take the form of prohibitions or requirements?** Some regimes . . . employ prohibitions and give rise to a need to deter potential violators from disregarding the relevant bans. Others . . . emphasize requirements and necessitate efforts to compel subjects to fulfill these requirements. . .

**12. Are the relevant bans embedded in prohibition regimes absolute or partial?** Some bans (e.g. the rules against the killing of endangered species or shipping hazardous wastes across boundaries in the absence of prior informed consent) are absolute; others (e.g. rules prohibiting the harvesting of fish in certain locations or in excess of certain quotas) are partial. Total bans are generally easier to enforce than partial bans. ...

**15. How violation tolerant is the regime?** Some regimes are almost certain to collapse or come unraveled in the absence of near perfect compliance; others can tolerate comparatively high levels of non-compliance and still continue to play an important role in dealing with the problem at hand. ...

### **Conclusion**

It is essential to bear in mind that institutions never explain all the variance in the dynamics of social-ecological systems. Numerous other factors – both biophysical (e.g. climate change) and socioeconomic (e.g. technological developments) – are always operative in such systems. ...

## **4.2 Scenarios**

Scenario planning began as a tool for businesses to consider future environments and prepare accordingly. Thus many of the descriptions of scenario planning come from a business management perspective, but are still useful in the ECE environment.

### Scenario Planning: A Tool for Strategic Thinking

P.J.H. Schoemaker, 1995

#### **A Planning Tool**

Suppose you are planning to climb a mountain. Previous planning would provide you a detailed map describing the constant elements of the terrain. Of course, this traditional planning tool is very valuable and, indeed, indispensable in this case. Just as geographical mapping is an honored art and science, so corporate mapping can be very useful. However, it is incomplete. First, it is a distorted representation (i.e., any two-dimensional map distorts the earth's surface). Second, it ignores the variable elements, such as weather, landslides, animals, and other hikers. The most important of these uncertainties is probably the weather, and one option is to gather detailed meteorological data of past seasons, perhaps using computer simulations.

However, scenario planning goes one step further. It simplifies the avalanche of data into a limited number of possible states. Each scenario tells a story of how various elements might interact under certain conditions. When relationships between elements can be formalized, a company can develop quantitative models. It should evaluate each scenario for internal consistency and plausibility; for example, high visibility and heavy snowdrifts are an implausible combination. Although a scenario's boundary might at times be fuzzy, a detailed and realistic narrative can direct your attention to aspects you would otherwise overlook. Thus a vivid snowdrift scenario (with low visibility) may highlight the need for skin protection, goggles, food supplies, radio, shelter, and so on.

Scenario planning differs from other planning methods, such as contingency planning, sensitivity analysis, and computer simulations. First, contingency planning examines only one uncertainty, such as “What if we don’t get the patent?” It presents a base case and an exception or contingency. Scenarios explore the joint impact of various uncertainties, which stand side by side as equals.

Second, sensitivity analysis examines the effect of a change in one variable, keeping all other variables constant. Moving one variable at a time makes sense for small changes. For instance, we might ask what will happen to oil demand if the gross national product increases just a fraction of a percent, keeping everything else constant. . .

Third, scenarios are more than just the output of a complex simulation model. Instead they attempt to interpret such output by identifying patterns and clusters among the millions of possible outcomes a computer simulations might generate. They often include elements that were not or cannot be formally modeled, such as new regulations, value shifts, or innovations. Hence, scenarios go beyond objective analysis to include subjective interpretations.

In short, scenario planning attempts to capture the richness and range of possibilities, stimulating decision makers to consider changes they would otherwise ignore. At the same time, it organizes those possibilities into narratives that are easier to grasp and use than great volumes of data. Above all, however, scenarios are aimed at challenging the prevailing mind-set. Hence, scenario planning differs from the three aforementioned techniques in its epistemic level of analysis. . .

### **Constructing Scenarios**

...

Since scenarios depict possible futures but not specific strategies to deal with them, it makes sense to invite outsiders into the process, such as major customers, key suppliers, regulators, consultants, and academics. ... The objective is to see the future broadly in terms of fundamental trends and uncertainties. ... The overall purpose is to build a shared framework for strategic thinking that encourages diversity and sharper perceptions about external changes and opportunities.

Next I describe the process for develop scenarios.

**1. Define the Scope.** The first step is to set the time frame and scope of analysis. ... [A]sk what knowledge would be of greatest value to the organization [within the time frame that is set]. It is useful to look at the past and think about what you wish you had known then, that you know now. What have been past sources of uncertainty and volatility?

**2. Identify the Major Stakeholders.** Who will have an interest in these issues? Who will be affected by them? Who could influence them? . . .

**3. Identify Basic Trends.** What political, economic, societal, technological, legal, and industry trends are sure to affect the issues you identified in step one? . . .

**4. Identify Key Uncertainties.** What events, whose outcomes are uncertain, will significantly affect the issues you are concerned with? ... For each uncertainty, determine possible outcomes. . .

**5. Construct Initial Scenario Themes.** Once you identify trends and uncertainties, you have the main ingredients for scenario construction. . .

**6. Check for Consistency and Plausibility.** The simple worlds you have just made are not yet full-fledged scenarios, because they probably have internal inconsistencies or lack a compelling story line. . .

**7. Develop Learning Scenarios.** From this process of constructing simple scenarios and checking them for consistency, some general themes should emerge. ... The goal is to identify themes that are strategically relevant and then organize the possible outcomes and trends around them. . .

**8. Identify Research Needs.** At this point, you may need to do further research to flesh out your understanding of uncertainties and trends. The learning scenarios should help you find your blind spots. . .

**9. Develop Quantitative Models.** After completing additional research, you should reexamine the internal consistencies of the scenarios and assess whether certain interactions should be formalized via a quantitative model. . .

**10. Evolve toward Decision Scenarios.** Finally, in an iterative process, you must converge toward scenarios that you will eventually use to test your strategies and generate new ideas. Retrace steps one through eight to see if the learning scenarios (and any quantitative models from step nine) address the real issues facing your company. Are these the scenarios that you want to give others in the organization to spur their creativity or help them appreciate better the up- and downside risks in various strategies? If yes, you are done. If not, repeat the steps and refocus your scenarios....

How can you determine if your final scenarios are any good? The first criterion is relevance. To have impact, your scenarios should connect directly with the mental maps and concerns of the users.... Second, the scenarios should be internally consistent (and be perceived as such) to be effective. Third, they should be archetypal. That is, they should describe generically different futures rather than variations on one theme. Fourth, each scenario ideally should describe an equilibrium or a state in which the system might exist for some length of time, as opposed to being highly transient. ... In short, the scenarios should cover a wide range of possibilities and highlight competing perspectives (within and outside the firm), while focusing on interlinkages and the internal logic within each future.

...

### **Conclusion**

When contemplating the future, it is useful to consider three classes of knowledge:

1. Things we know we know.
2. Things we know we don't know.
3. Things we don't know we don't know.

Various biases—overconfidence, under- and over-prediction, the tendency to look for confirming evidence—plague all three, but the greatest havoc is caused by the third. Although there are no foolproof techniques, focusing attention on two and three can gain much improvement. And this is where scenario planning excels, since it is essentially a study of our collective ignorance. ... The scenario method continually pushes the envelope of possibilities since it views strategic planning as collective learning.

Good scenarios challenge tunnel vision by instilling a deeper appreciation for the myriad factors that shape the future. ...

## **4.3 Simulation modeling**

Simulation modeling leverages the power of modern computing to represent and analyze real-world systems which may be too complex for straight-forward calculation or simple conceptual analysis. One of the most famous examples of the technique is the use of general circulation models (GCMs) to better understand and predict the earth's climate. However, simulation modeling is not only useful when analyzing physical systems, and is one of the most widely used techniques in operations research and management science. (Law and Kelton 1982) Its

ability to handle complexity and non-deterministic behavior make it well suited to analyze ECE problems and predict the outcomes of ECE strategies.

### Simulation Modeling of Environmental Problems

Edited by F.N. Frenkiel and D.W. Goodall, 1978

#### **Simulation Modeling and Systems Analysis**

A simulation model is based on a mathematical representation of the dynamics of a real-life system. Some such models are analytical—in other words, once the initial conditions have been determined, the state of the system at any future point in time is given by the analytical solution of a set of differential equations. When the problem of finding an analytical solution becomes too intractable, one must turn to *simulation modeling*.

Simulation modeling uses another medium (usually mathematics, or computer programs) to mirror the processes and interrelationships of a real-life system in a *model*. This model—this analogue—of the real world is caused to go through a series of changes controlled by its structure. The changes in the model are then said to simulate the changes which the real-world system, with its analogous structure and linkages, would undergo in a comparable situation. The simulation thus permits insights into the behavior of the real-world system—insights whose reliability depends on the closeness of the analogies between the model and the real world.

Although simulation modeling may sometimes use relatively unsophisticated graphical techniques, or electrical circuitry, as an analogues of the real-life processes in the systems modeled, it usually involves the use of computers for the digital solution of large sets of differential or difference equations.

In a discrete-time simulation model (conceptually the simplest to grasp), the changes in the system during any short interval of time are expressed in terms of the state of the system at the beginning of that interval, together with any external factors known or postulated to impinge upon it during the interval. Changes during the interval are then calculated, and the new state of the system at the end of that interval and the beginning of the following one is deduced. This new state then becomes a starting point for calculation of changes during the second interval, and so forth. This discrete-time approach is often replaced by one in continuous time, where one needs to speak of rates of change rather than changes during an interval, and differential equations replace the difference equations of the discrete model.

The simulation approach gives great flexibility in expressing the dynamics of a complex system. No particular mathematical form need be assumed for the relationships existing in the system; the constraints are only those inherent in the nature of the real-life system itself, and the mathematics merely reflects the assumptions made about the physical system modeled. ... What is important is only that all the functions should be well defined for all conditions that may exist in the system, and defined in terms of variables occurring within the system or of known or assumed inputs from the outside.

Since the operation of a deterministic model (i.e. one in which, given the current state of the system and the inputs, the future state and outputs are uniquely defined) is a straightforward process of logical deduction, it is well suited to the use of a digital computer....

Of course, it may well be that the system under consideration is inherently uncertain in some way, perhaps because of random (stochastic) inputs, or because the behavioral

mechanisms are defined only in a statistical sense. In this situation, the model may be designed to reflect this uncertainty either by statistical treatment or by the inclusion of explicit stochastic variables.

Simulation models ... are mainly intended as predictive tools—that is, their prime purpose is to predict the future state of an environmental system, given its present state and a set of postulated future values for factors which may influence it. ...

#### **4.4 Resilience, vulnerability, and adaptation**

The field of panarchy is developing new methodologies that may be relevant to research on environmental compliance and enforcement. The following excerpt is from a new PhD-level course at the Bren School.

DRAFT Course Outline  
23 February 2005

#### **ESM 595 – Spring 2005**

Resilience, Vulnerability, and Adaptation in Ecosystems, Social Systems, and Social-Ecological Systems

Instructors: Lenihan (natural science), Young (social science)

This team-taught course offers (i) a critical survey of recent conceptual and analytical work on the dynamics of ecosystems, social systems, and, especially, social-ecological systems or SESs, (ii) an account of new developments in models and analytical tools available for the study of these systems, (iii) an examination of the strengths and weaknesses of these models and tools,...

Our approach to this subject arises from two initial observations. First, although human actions have always affected biophysical processes in significant ways, we live today in a world of human-dominated ecosystems or in an era that many now call the Anthropocene. This makes it essential to focus on social-ecological systems and to develop models capable of dealing with the dynamics of these coupled systems.

Second is the observation that different streams of analysis dealing with these topics seldom converge and often lead to conclusions that bear little resemblance to one another. A dramatic example involves the disconnect between economic models and ecological models regarding matters like climate change, the loss of biological diversity, and land-use practices. Somewhat similar comments are in order regarding the work of ecologists focusing on the idea of resilience and geographers concerned with the vulnerability of various systems.

As a procedure for cutting into this set of issues, we will direct attention to the work reported in Gunderson and Holling eds., *Panarchy: Understanding Transformations in Human and Natural Systems*. There is nothing sacred about this analytic framework. But the book offers what is perhaps the leading compilation of work on the dynamics of social-ecological systems. Prepared for the most part by ecologists and focused largely on resilience as a dynamic phenomenon, this collection of essays presents one clear line of thinking regarding SESs.

By applying this framework to a range of empirical systems and drawing on other literature as a source of contrasting approaches, we aim to move toward the development of a more powerful set of analytical and methodological tools for understanding the behavior of SESs. Ultimately, we seek to create a set of models and methodologies that can generate the intellectual capital needed to underpin the efforts of the Bren School to train environmental professionals by integrating the contributions of environmental science and management.

#### A. Socio-ecological Systems: Concepts, Models, and Methods

##### 1. Systems approaches in the natural and social sciences: Boundaries, stresses, Regime shifts, and transformation

Schoon, "A Short Historical Overview of the Concepts of Resilience, Vulnerability, and Adaptation"

Janssen et al, "Scholarly Networks on Resilience, Vulnerability, and Adaptation"

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##### 3. Social-ecological systems: Analytic frameworks and critiques

Holling and Gunderson eds., *Panarchy*, 3-62

Carpenter et al., "From Metaphor to Measurement"

Turner et al. "A framework for vulnerability analysis in sustainability science"

Turner et al., "Illustrating the coupled human-environment system for vulnerability analysis: Three case studies"

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#### C. Policy Implications, Management Regimes, and the Role of Science

##### 8. Adaptation and learning

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##### 9. Institutional systems – management regimes

Young. "Matching Institutions and Ecosystems" & "Institutional Dynamics: Resilience and Vulnerability in Environmental and Resource Regimes"

##### 10. The science/policy interface

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