Models, Facts, and the Policy Process: The Political Ecology of Estimated Truth

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Abstract

In the past three decades, models based on econometric information and information from participation in large governmental programs have become important components of the policy making process. It is likely that models based on Geographic Information Systems shall follow suit. There is temptation to believe that models, by providing superior factual guidance, significantly transform the policy making process. Experience to date suggests they do not, but rather are swept up into the process, and become part of it with all its strange features. Previous work on models in the policy process is recounted in this paper. It shows that models are most extensively used as weapons in political and policy warfare, and it is in these uses that they make their greatest contribution. This "datawars" perspective requires that models be used pluralistically from different sides of the policy perspective, and not as an "arbiter of truth" in the center. GIS-based models have particular characteristics that make them highly likely to be incorporated in policy making. The challenge to develop an effective "datawars" perspective on GIS-based model application is upon us, and suggestions are provided to help modelers deal with the challenge.

Models, Facts, and the Policy Process:
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"Before I draw nearer
to that stone to which you point,"
said Scrooge, "answer me one question.
Are these the shadows of things that Will be,
or are they the shadows of things that May be, only?"
(C. Dickens, *A Christmas Carol*)

Introduction

It's a truism that better information leads to better decisions. And in the ongoing effort to improve decision making in public and private organizations, the effort to improve information available for decisions is paramount. We live in an era obsessed by the notion that knowledge is power. And technologies for managing information bring knowledge to the fore like never before possible. But do these technologies allow us to say, via transitivity, that information technology is power? The answer depends on how the technologies are put to use.

Recent advances in computer-assisted information management, and particularly those in modeling of reality, have heightened our awareness of the need to refine not only our technologies but our techniques for using them. It is not enough to know how to build a powerful data base, a sophisticated model, a glitzy display, unless the sole objective is to win the local science fair. If one wants to use these technologies to make changes in the world, it is necessary to know how they fit into the world. And more important, it is necessary to know that the world is a lot bigger than these technologies. How does the feather move the boulder?

This paper provides a particular view on the role of modeling, facts, and knowledge generally, in the making of policy. The focus here is mainly on public policy, since any clear understanding of public policy formation will contain as a subset most of what's needed to understand policy making in the private sector. The paper is motivated by a tradition of research on model use generally (Gass, 1983), coupled with our research over 18 years into the uses of computers and telecommunications technologies in complex organizations. In particular, it draws on extensive studies of role of computer-based models in local and national policy making [1]. The models investigated are not, strictly speaking, "GIS - based." Rather, they are mainly economic and program policy models. Nevertheless, these models offer a useful perspective on the role of modeling in policy making that should be of interest to those attempting to apply GIS-based models to actual policy problems. In particular, the paper explores some of the common myths of the role of knowledge in policy making, and focuses specifically on the political character of information technologies, their use, and their outcomes. Effective use of technology in

policy making depends on making the technology purely political. The paper concludes with some suggestions for making this happen.

The "Datawars" Perspective on Modeling in the Policy Making Process

In 1977 we were asked by a group of researchers at a (then) West German national laboratory why models for policy making support were routinely used in U.S. federal government agencies. They asked the question because they had been developing such models for use in the German federal ministries, and had met with dismal failure. Even their most technically successful model, BAFPLAN, a microanalytic simulation model for predicting participation rates in the national college student assistance program, had met with only lukewarm acceptance. Gazing across the Atlantic, they noticed that models of this kind were in routine use in the United States, and in fact, appeared to be having an effect in the policy making process. Why, they wondered, were the Americans more successful at such modeling?

Our German colleagues reasoned that the models used by the Americans were not likely to be better than those they had developed. Most of the models were similar in concept and construction, and the Germans knew their technology for modeling was as good as anyone's. The likely answer, it seemed, was in the *implementation* of the models. The Americans had apparently figured out a much more successful procedure for implementing models in the policy process. And indeed, Greenberger and colleagues (1976) had recently reported the results from a study that suggested that model implementation was often the most troubling phase of the policy modeling effort. Preliminary results of Brewer and Shubik's (1979) study of simulation in military planning suggested the same thing. And the management science literature generally was awash with discussion of the problems of model implementation (Schultz and Sleven, 1975; Fromm, et al, 1975; GAO, 1976; House and McLeod, 1977; Radnor, et al., 1970; Rubenstein and Tansik, 1970). If implementation was the issue, and the Americans had improved implementation procedures, the sensible thing for the Germans was to ask the Americans how their model implementation procedures worked and why they worked so well.

We commenced a study called IMPMOD, or Implementation of Models, that lasted from 1978-1981. We studied two broad classes of models: macroeconometric models used most often in economic policy making by the Treasury Department, the Congressional Budget Office, the Office of Management and Budget, and the Federal Reserve; and microanalytic simulation models used mainly in assessment of complex policies for taxation and social welfare programs [2]. We also looked in some detail at the BAFPLAN experience, though this was not a formal part of the study. The study consisted of a series of detailed case studies of model development, implementation, and use, plus reanalysis of the Fromm, Hamilton and Hamilton (1975) survey of federal model use. The results of the study came mainly from the case studies.

We discovered, much to our surprise, that American success in model use came about largely *in spite* of the characteristics of the models or the plans for their implementation.

In fact, by studying only the models and their implementation, we could discover very little of interest from the standpoint of model use. Rather, it was in studying the way the models were actually used in the policy process that we discovered why they were used so widely. Put simply, the models were used because they were effective weapons in ideological, partisan, and bureaucratic warfare over fundamental issues of public policy. Those models that were most successful, as measured by the extent of their use, were those that had proven most effective in the political battles over what kinds of economic and domestic policy should be followed, whether Democrats or Republicans should get the credit, and which bureaucratic agencies would receive the power and funds to implement the policies. Successful combatants in the policy debates had to have strong models of their own, and moreover, they usually needed copies of the oppositions' models as well, in order to mount their offensive and defensive campaigns. Models in federal policy making were successful as a result of what we called "datawars" – the explicit use of model-based information in policy warfare.

These discoveries produced a result our German colleagues had not anticipated. The German experience with modeling reflected not so much the character of their models, or the nature of their implementation efforts, but the basic structure of their mechanisms of technocratic support for policy making. While the German parliament, Chancellorship and executive agencies were democratic and pluralistic, the "technical" side of public policy making in Germany was highly restricted to long-established and highly independent entities such as the Bundesbank, the national banking authority, and the Bundesstatistischampt, or federal statistics office. The former was powerful and independent because it was established so by law (similar to the U.S. Federal Reserve). The latter was powerful and independent because of a long tradition of assuming that technical expertise is "non political," and therefore not to be questioned except on technical correctness. Both agencies saw it in their interest to maintain a tight hold over all technical supports for policy making, as part of their "skill bureaucracy" – their bureaucratic hold over power by virtue of technical skill. However, neither saw any incentive to become embroiled in genuinely political fights involving their models and data, simply because they could not guarantee the outcomes of such fights. They could, they feared, end up losing not only the support of powerful interests in the government by taking the "wrong" side, but even worse, failure to prevail could undermine confidence in the technical "correctness" of the models and technologies themselves. As a result, the Germans had great difficulty getting models into sufficiently serious policy discussion to even warrant their use, much less a central role in policy debates. In the rough-and-tumble world of true democracy, "pure" models were as useless as "pure" science and "pure" technology.

The Inherent Politics of Modeling

Since the early 1980's we have seen the power of models as genuine political instruments in the policy process. In fact, during our field work for the IMPMOD study, we discovered that even potent changes in leadership ideology at the top did not permanently disturb the pluralistic infrastructure of modeling down below. In fact, it made it more robust. When the Reagan Administration swept into office, carrying not only a

conservative president but a conservative Senate with it, the word quickly went out that the "old" ways of thinking and doing business were doomed. Many predicted that the modeling efforts on the economic side, which were based mainly on post-Keynesian theory, and thus in conflict with supply-side "Reaganomics," would be eliminated from the executive branch. In fact, even the staunchest Reagan aides soon discovered quickly that they could not control the discourse of models because formal economic modeling was too well established in the fabric of policy debates.

A major thorn in the Administration's side was the Congressional Budget Office, CBO, which had been established in 1974 to provide an analytical counterweight to the President's hegemony in budget analysis capability. The CBO had grown greatly in stature and expertise in only six years, and had acquired all the top macroeconometric models. It depended critically on them for forecasting the balance between revenues and expenditures necessary for the House and Senate committees charged with ways and means and budgets to do their constitutionally mandated jobs. CBO also depended on the inputs from the microanalytic simulation models for taxation and welfare policy to calibrate their estimates of the actual revenues that would be generated under different taxation schemes, and the demand for welfare services under different scenarios. Even the conservative members of the Senate fell silent when they confronted the prospect of making tax and budget judgments with nothing more than ideology and guesswork to back them up. The models, as problematic as they might be, offered something. And what they offered, in particular, were numbers derived from established, well-understood processes of analysis. As Jodie Allen, Deputy Assistant Secretary of Labor had explained, in the heat of policy battles, "some numbers beat no numbers every time."

The new conservatives had no numbers, and although they gained a few quick victories through the power of their stunning electoral mandate, they soon found themselves frustrated by the modeling results the opposition was consistently placing on the table to "prove" the disastrous consequences of conservative policies. The conservatives discovered that long-run success depended on having versions of the opposition's models to determine what kinds of offensives they would face, and if possible, a solid arsenal of offensive models of their own. The major models used during previous administrations remained in place in all the executive agencies as well as the Fed and CBO because they were essential to political strategy. Also, they were the only game in town when it came to providing systematic estimates of likely consequences from different policy actions. The conservatives responded with some modest ammunition of their own, too. In relatively short time, several "supply-side" economic models were produced, including the controversial "Claremont Model," which was soon discredited by economists of both sides as incomplete and naive at best. More substantial modeling efforts incorporating conservative viewpoints were undertaken by the model providing companies on the macroeconometric side, such as DRI, Chase Econometrics, and Wharton Economic Forecasting Associates, while both Mathematic and The Urban Institute found demand for their MATH and TRIM models had not slackened. Models had become a permanent part of the discourse of national policy making.

Modeling is here to stay in national policy making. The experience with economic and social welfare models has been repeated with modeling in other arenas such as

agriculture, energy, education, transportation, and of course the military. The reasons for this success of modeling are less "rational" and "scientific" than many scientists and policy analysts care to think. Rather than providing a base of information and analysis that produces the "correct" answer, thereby causing consensus under the "truth wins" decision rule, models often serve to channel discussion in ways that provide offensive or defensive advantage to particular parties. To some, this is an unfortunate outcome, "politicizing" the use of models. To others, however, it is a desirable outcome because it shows that models can be incorporated and used in the inherently political process of policy making in a democracy. In fact, it can be argued that efforts to keep modeling out of politics, or even the less intentional development of modeling infrastructure that biases model use away from intensely political application, is the surest route to marginalization of models as tools for policy analysis. If they are not useful as weapons in political debate, they will have little or no role in such debate.

A Constructive Role for Modeling in Policy Making

The question arises, at this point, whether models have any role in policy debate other than a purely political role as weapons. Or put differently, does the use of models contribute anything besides grist for the mill of political haggling? This is an important question, because if the role of model use is limited to political warfare, models will at best be the pawns in a seemingly endless modeling "arms race." There will surely be a role for purveyors of models in such a scenario, but one wonders whether there is anything particularly noble or valuable in modeling in such a situation. In this regard, we are optimistic. Our studies of modeling and computer-based information systems for decision making in the IMPMOD and other projects convinces us that models do play an important, substantive, and constructive role in policy formation. This role is not in the corny form of the "answer machine" that provides policy makers with the "truth" about a given situation. Rather, the models tend to have three singular and powerful influences on the policy process as a political form of game playing.

The first role of modeling is its role as a clarifier of issues in debate. Modeling is a systematic and formal process of analysis that requires specification and documentation of assumptions. Most complex policy problems require models with large substantial investment in infrastructure – technology, skilled people, and data resources. Every modeler must admit to constraints on each of these components of infrastructure, and every sensible modeler makes compromises along specific lines of reasoning to accommodate the constraints. These compromises make obvious the fact that models are incomplete efforts to describe real phenomena. The essential question for every critic of models is, what gets in and what's left out? The answer reveals the biases of the modelers; their assumptions, ideologies, world view, and so on. And these biases are the bases of serious political discourse. In a model, the modeler's biases are written in hard code and documentation, which then invites serious scrutiny. The critics can then question why certain variables are included vs. excluded, or why this variable is treated exogenously vs. indogenously, or why variables are weighted as they are. The model provides a systematic argument for and against various biases, by its very nature. The model becomes the Rosetta Stone by which policy analysts with different biases can

speak a common language to debate critical assumptions. In the words of Dutton and Kraemer (1976), the model becomes a key focus of negotiation about what makes sense and what does not in the essential phase of setting ground rules for the debate. In the words of King and Star (1990), the models become "boundary objects" that bring together people from different social perspectives. Models are a way of defining common ground.

The second role of modeling is its role in enforcing a discipline of analysis and discourse. The singular power of modeling is consistency: a good model will return results that differ only in appropriate amounts given changes in particular inputs (e.g., changing the coefficient of an exogenous variable). A model is a kind of mechanical thing; willy-nilly tinkering with it in an effort to produce temporary political advantage will usually produce results that are wildly out of bounds. This constrains the ability of the modelers on all sides of a debate to engage in bluffing or deception, particularly when all sides have access to each others' models. Instead, each side must adhere faithfully to the technical realities of modeling, even if they disagree wildly over the biases inherent in different models. Again, this enforces discipline and attention to the underlying issues as well as to the essential but troublesome questions of how particular results might be obtained. Everyone knows that the Spirit of Modeling produces the shadows of what Might be, only. No one knows what Will be. But there can be better or poorer shadows, depending on the quality of the model. And quality of analysis and information therefore becomes a justifiably important issue in debate.

Finally, models do provide an interesting and powerful form of "advice." It is not remotely close to the "correct answer" envisioned by Simon (1960) and others, wherein the technological wonders of management science would give decision makers answers to the questions of what they should do. Rather, it is advice on what not to do. The best models point out just how bad the results of a truly problematic policy might be, and this proves to be exceedingly valuable in the policy making process. An example of such powerful use of modeling was uncovered in our IMPMOD study. The Treasury Department uses a microanalytic simulation model called the Personal Income Tax Model, or PTIM. This model uses a snapshot of 50,000 taxpayer returns gathered at a specific point in time, and "ages" that population of returns (e.g., raising/lowering incomes, altering exemption and deduction profiles, etc.) in a manner consistent with demographic projections under different scenarios. Proposed changes in tax policy are then run against the aged population to provide a picture of probable results (e.g., changes in revenues, tax incidence, etc.) The PITM might well be the most heavily used model for policy analysis in the world. In 1980 there were nearly 1,500 runs of this model – an average of more than six every working day. The majority of runs were requested by members of the administration or congress interested in changing some aspect of tax legislation. They had discovered that the model was good at showing which proposals were likely to produce politically unpalatable results, such as proposals for new taxes that would cost more to administer than they would raise in revenue. Politicians of every political stripe routinely ran their proposed tax bills through the PITM, simply to avoid making fools of themselves.

A qualification is in order on the matter of modeling's contribution to the quality of decision outcomes. Major tax legislation was indeed passed during the Reagan

Administration, and the PITM correctly forecasted decreases in revenue that would result, with serious consequences for the federal budget deficit. But at that time the groundswell of ideological support for tax law changes was so strong that the PITM's forecasts were eclipsed by the larger political reality. Leaders from both parties were trying to make tax reform "their" issue, so the question was not whether there would be radical reforms, but what the reforms would look like. The expected magnitude of reform was so far from the baseline on which the PITM was built that it was arguable that the PITM's forecasts would not be very good anyway. The results of radical changes are unlikely to be predicted accurately by models based on the performance of variables under the status quo. But radical reforms are uncommon, so this pitfall of modeling is seldom encountered.

We concluded from our work that models do not prevent (or cause) any particular policy changes. They simply provide policy makers with an idea of whether the proposed policies are likely to produce results in an "acceptable range." In this way, modeling helps diminish the number of policy proposals that look good superficially, but that can be shown by systematic analysis to have very serious downside consequences. This contribution, coupled with the "boundary object" role of models, and the enforcing of discipline that model use produces, has salutary effects on policy making. One way of thinking about these effects is to assume that, where the facts really matter in a policy debate, modeling can provide a useful adjunct. The contribution is not from giving the right answer, but in helping sort out the nature of the debate, focusing disciplined attention on the issues, and setting boundaries likely to contain "sensible" outcomes. Models are not much use in times of ideological upheaval, simply because the decisions are based on beliefs rather than facts. Ideological policy makers appeal to their own versions of facts, and dismiss the facts of others as falsehoods. In this way, the fundamental assumptions of policy modeling are upended. But no radical reforms can persist for long. Eventually, a new status quo emerges, and as it does so, sufficient policy stability to support modeling reemerges. Again, the utility of modeling as an adjunct for incremental policy making comes into the foreground.

A Perspective on "Scientific Modeling"

At this point, the experienced reader might ask whether the kinds of models discussed above are not "social science" models, and thus quite different from the "scientific" models of physical processes of the environment toward which GIS-based information might be directed. The question requires a qualified response.

To start, we must ask if the two kinds of models are truly different, and if so, what consequences might such differences have in policy terms. It can be argued that the modeling of certain physical phenomena can be done with greater efficacy and precision than can modeling of some social phenomena. Finite element analytical simulations, for example, predict almost exactly how a structure will behave under particular stresses. In contrast, macroeconometric simulations of the national economy seldom predict anything very exactly. Thus, we could conclude that "scientific" models represent the "truth" more vividly, as demonstrated by their predictive power, and that they will be readily accepted into the policy process.

Curiously, however, the policy relevance of scientific models that are "always right" is already moot. To the extent that anything can be predicted with precision, as can the structural behavior of a particular bridge design, the effect of such precision is to move the models out of policy altogether and into the realm of engineering expertise. Few legislative bodies will tangle with the risks associated with bridge design, because failures are so noticeable and disastrous. Engineers stand ready to build bridges for almost any occasion, and they use models to do so. But their models lose their utility when one steps back into the question of whether a bridge should be built, or where it should be built, or how large it should be, or how it should be paid for. These questions force the modeler back into the "social" realm where the word "science" is something of a euphemism.

Engineering models have narrowly circumscribed utility, but policy models do not. In fact, policy models suffer from the peculiar dilemma they are most useful when the truth is not altogether clear. Policy models are useful only as projections into the future, and the future is up for grabs. There is no policy utility whatsoever for a model that correctly predicts retrospectively how things actually came out. All politicians can do that. And there is little comfort to a politician in knowing that a given model has retrospectively predicted what's already known unless there can be a *guarantee* that predictions of the future will be accurate. Since no honest scientist is willing to make such a prediction, the "distance" between social science models and scientific models becomes one of degree and not of kind.

We believe the experiences with social science models are excellent bellwethers of modeling in the policy process, regardless of how "scientific" the models might be. The reason for this is simply the nature of the policy process. Models are useful when the fundamental questions of what might happen are unclear. Once everyone agrees on the facts, there is no further need for models to clarify the facts. Consider the ongoing efforts to model the economy. Everyone argues about what will happen, but no one argues for long with what is happening. The 1992 presidential campaign offered a wonderful example, in which the incumbent president, George Bush, was forced out of a position of denial about the recession and into an active campaign to convince voters that his economic programs would do the most to overcome the recession. The models were turned from trying to show that the country was or was not in a recession, and toward the question of what policies would best get the country out of the recession.

This could be cited as an example of the fuzziness of social science models, but exactly the same thing can be said about "scientific" modeling of the environment. A good case in point is provided by the current rush of concern about depletion of the ozone layer. Models predicting serious depletion of the ozone layer due to CFC's and other chemicals were laughed at by a substantial majority of the atmospheric science community as well as policy makers for many years. No amount of modeling changed the prevailing view. The response was always the same: more data are required before policy conclusions can be drawn. But resistance to the ozone depletion argument began to weaken once the ozone "hole" was found over Antarctica in the mid-1980's. And in 1992, when a significant "hole" was found over North America, politicians were suddenly of one voice to curtail the production and use of ozone-depleting chemicals. The issue of "whether"

appeared to be solved, while the question of what to do about it moved to center stage, along with numerous, conflicting model-based predictions of what should be done.

Prediction is not proof. Even the seemingly airtight "laws" of thermodynamics are of little weight when the political bias is against them; a poignant lesson learned not long ago by the people of the United States, the administrators of NASA, and the friends and families of the seven astronauts aboard the *Challenger's* final flight..

Modeling in the Age of Geographic Information Systems

We believe the experiences we witnessed in the use of macroeconometric and microanalytic simulation models in national policy making will be recapitulated in the application of GIS to the policy process. This prediction is based on the abiding character of the policy process, which will not be changed by any kind of technological breakthrough. What differences, if any, might we see from GIS application that we did not see in our earlier studies? Two come to mind.

First, the peculiar character of geographic data bases is an important element in the GIS role in policy making. As proponents of geographic data base construction have maintained for many years, everything in government (and public policy) is one way or another tied to the earth. And despite the dynamic character of the earth, such as changing shorelines or riverbanks, and differences of opinion on what names to apply to particular areas, such as "wetlands," it is possible to create a fairly reliable record of land characteristics that everyone in a policy debate will agree on. This forms a powerful boundary object; one much more powerful than those created by the macroeconometric or microanalytic simulation models. For one thing, the basic elements of a geographic data base are tangible and observable, while notions like the "money supply" or "propensity to participate in program" are not. Moreover, geographic facts tend to remain facts over time, which makes them by themselves boundary objects. Geographic data bases will naturally draw together policy makers of different perspectives simply because they agree on these basic facts, but they disagree on what to do with what is represented by those facts. This is a blessing and a curse for GIS use in policy making, at once drawing policy makers to GIS as a support for their work, but on the other hand, making the GIS the battlefield of intense debate. Rising to the occasion offered by that battlefield role is a major challenge of GIS professionals.

Second, the very breadth of GIS application to policy problems makes GIS likely to be pulled into many different kinds of policy debates. Unlike the worlds of modeling for economic planning or welfare policy analysis, where idiosyncratic models served each policy need, GIS are likely to support a plethora of models for many policy needs. This too will be a challenge for GIS professionals, because different policy debates take on widely different characteristics. Debates about land use or environmental pollution abatement typically pit economic interests of industrialists and land developers against environmental groups interested in maintenance or restoration of areas and in limiting growth. Debates about policies to fight crime are of a different character altogether, focused on determining appropriate levels of law enforcement, deployment of law enforcement resources, and locations of jails and other correctional facilities. Debates

about traffic and transportation management often pit advocates for various transportation "solutions" (slow growth, roads, fixed rail rapid transit) against one another, and increasingly, they pit governments short on resources for essential transportation infrastructure against developers who want to develop land but not pay for the full costs of infrastructure required to support such development. GIS-based models can and will be used in each of these kinds of debates. Whether they are used constructively in the policy debate depends on the facility with which GIS professionals can adapt the systems to serve the arguments of different parties in the debates. If the models serve only particular interests, to the exclusion of others, the models will be challenged with the intent of destroying credibility in particular models or in modeling generally.

These challenges will not be met easily. They will definitely not be met through application of the naive notion that the "truth" will win in policy debates, and the corollary belief that any particular models contain the "truth." This notion is naive, but more dangerous, it is insulting to policy makers, including those who win as a result of using particular models in their arguments. Policy makers do not like to think of themselves as dependent on their staffs, and they particularly dislike being dependent on technics they cannot really control. A model that gives "true" answers might give the right true answers in one case, and the wrong true answers in another. And in any case, if everyone does agree on the truth of a matter, it ceases to be a policy issue and is remanded to administration for disposal.

GIS modelers, and modelers in general, have several tasks before them in the quest to achieve widespread and constructive use of models in the policy process. This brief list illustrates the most important:

1. Modelers should avoid believing or giving the impression that their models hold the "answers" for policy makers. They hold, instead, the refined results of particular points of view. The difference is critical, and modelers must be sure policy makers understand the difference.

2. Modelers should recognize the biases inherent in their own models, and that such biases are inevitable in any serious model. Moreover, these biases are the bases of essential public policy debate, and model use can focus required attention on these biases while not depriving modeling per se of any of its power. The constructive consequences of such recognition are to encourage development of multiple models, each incorporating different perspectives, and thereby allowing for comparison of results from the different models/perspectives as part of debate.

3. Modelers should encourage those they work for to support broadening access to modeling by all parties in the debate. Efforts to keep different parties out only damage the credibility of modeling itself, suggesting that the models will not stand up to scrutiny by opponents. In such debates, models soon become little more than "fire once and forget" tools, good for one or two wins and soon abandoned.

4. Modelers should work to build the common infrastructure of modeling across all parties in debates, and in particular, the common data sets required for understanding the issues and the modeling techniques that improve simulation and forecasting accuracy.

5. Modelers should join those public policy debates that align with their own political beliefs whenever possible, bringing the skills and tools of modeling to their side of the debates.

6. Modelers should ensure that legitimate policy positions in debates that do not have modeling support obtain necessary support, either as an entitlement of participation in the policy process, or via third-party arrangements involving philanthropic or other organizations.

Conclusion

Success of GIS-based models in policy making will depend on the skill and felicity with which GIS professionals develop and adapt their models to serve the analytical needs of the largest number of combatants in policy warfare. At one level, this sounds a bit disingenuous – like the arms merchant willing to sell to both sides in a conflict. But two factors make it more noble than that.

One is the fact that these models are not destructive; at worst, they are ineffectual, and at best, they help to strengthen the quality of the policy making process. To the extent that the GIS professional is "arming" the combatants, the arms are used in the fight against ignorance, confusion, and obfuscation. And the arms of modeling are successful only when all the combatants have them.

The other ray of hope is the fact that modelers are, themselves, fully capable as individuals of putting their talents to work for causes in which they believe. Thus, modelers who favor policy A can work for the proponents of policy A, and likewise for policy B, C, D, and so on.

Indeed, it makes little sense to assume that there can be, or even should be, one modeling group supporting all sides in a conflict. This is not realistic politically, and in any case, a modeling entity thus constituted will forever be on shaky ground. The ability of modelers to criticize and compromise with respect to each others' work in policy debates depends on comradery in the *profession* of modeling. It does not assume common ground on the issues themselves. This is a great strength of the "datawars" view of modeling in the policy process.

NOTES

[1] This work is the legacy of the research conducted at the Public Policy Research Organization of the University of California, Irvine, since the early 1970's. For readily accessible accounts of this research, see: Kraemer and King (1976); Danziger, Dutton, Kling and Kraemer (1982); Dutton and Kraemer (1986); King and Kraemer (1985),

Kraemer, Dickhoven, Tierney and King (1987); and Kraemer, King, Dunkle, and Lane (1989). This research was supported by the National Science Foundation and by the Gesellschaft für Mathematik und Datenverarbeitung (GMD) of the Federal Republic of Germany. Comments and queries may be directed to the authors at king@ics.uci.edu, or kkraemer@uci.edu.

[2] For the macroeconometric model study we concentrated on the Data Resources Incorporated national model and its associated time-series data bases. This model had been adopted for use by every federal government entity engaged in economic analysis. For the microanalytic simulation study we concentrated on two versions of the Real Income Maintenance model, which was first built as part of the 1972 President's Commission on Income Maintenance, and was subsequently elaborated as the Transfer Income Model (TRIM) and the Micro Analysis of Transfer to Households (MATH) models supported by The Urban Institute and Mathematica Policy Research, respectively. Details can be found in King (1984a,b), Kraemer and King (1986), and Kraemer, Dickhoven, Tierney, and King (1987).

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