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Alternative Designs For Policy Models Of The Agricultural Sector

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Introduction

Policy models are representations of systems formulated for the purpose of anticipating and evaluating outcomes of decisions that influence the functioning of the system. For static models, the decisions are introduced by selecting a set of values for the policy instruments under the control of the decisionmaker. The dynamic counterpart is a decision rule or strategy for determining values of the policy instruments based on external and system outcomes. Outcomes for the system are determined by its structure and the environment in which it functions. This environment can be specified by levels of conditioning factors in static contexts or time dimensioned structures for dynamic models.

The evaluation of policy models is on the surface a simple matter, Criteria ultimately employed are correspondences of system outcomes to those projected on the basis of the policy model. When the correspondence is close, the policy model is given a positive evaluation. The opposite is of course true as there is a lack of correspondence. Clearly, the term "close" requires additional definition. For example, policy models may suggest outcomes of actions which are inconsistent with those observed, not because of the model representation, but because of a failure to correctly anticipate the environment within which the system is functioning. Persistence of such results would, however, reflect on the model representation, indicating that the part of the environment responsible for the difficulty should be endogenized. Models resting upon environmental assumptions that can not be accurately projected or verified are of little value as decision-making aids. Thus, measures of predictive accuracy must take into account the uncertainty about the environment faced by the decisionmaker.

The problem of designing policy models as decision aids is the subject of the presenr paper. Three aspects of model design are of concern. The appropriate, or in some sense, optimal model design is first a function of the decisions or actions that the output is to support. That is, models should be designed to include as outcomes those variables used by the decisionmaker to evaluate the performance of the system. Also, they must encompass the policy instruments under the control of the decisionmaker. That is, the models must provide a structure whereby the settings of the instruments can be related to the values of the outcome or performance variables.

A second aspect of model design has been anticipated by the comments on evaluation. It is the scope of the model. Models must incorporate sufficient structure to permit the analysis of decision rules within a construct that has predictive integrity. Many of the statistical models employed to support policy analysis for the agricultural sector have not been sensitive to this question of scope. The performance of the models as decision aids has broken down because, although resolution within the models has been good, their predictions depended upon environmental variables that could both be accurately projected. In short, the scope of the models has been chosen without carefully evaluating the potential for implementing decisions based on their outcomes.

The final aspect of model design concerns the fact that models are approximations of systems. This must be if models are to contribute to decision making by pointing to key effects, responses or behaviors. Since models are approximations, means should be developed for adapting them to the systems, i.e., keeping the models current. This adapting or tuning of models is thus an important aspect of design, albeit one that has not received adequate attention by economists. Concerns with scope and the inclusion of relevant policy instruments and performance variables argue for larger and more comprehensive models. Limitations imposed by costs of information, computation and understanding of the structures favor smaller and less extensive models. The idea of models as approximations can be seen as an approach to achieving a workable compromise in this framework. Interestingly, the better the approximation the more successful a model can be at offsetting these two concerns.

Models should provide local, adaptable approximations to the systems they are designed to represent. It follows that the major design issues for model development are: (1) structuring and specializing the approximations and (2) adjusting the approximations so they are localized to represent the systems as currently positioned for policy making. The advantage of viewing modeling in this framework is the simplicity it provides for model specification and specialization or estimation.

The paper begins with a review of the experiences of economists in developing and applying policy models. Although brief, the review serves to identify prominent themes in the evolution of model design and to tie these themes to the evaluation of designs in an approximation framework. These themes receive a more synthesized treatment in the subsequent section on promising developments in model design. The next two sections address the major design issues of the paper, approximate models and procedures for making these approximations appropriately local. A final section raises the evaluation and design issues again but within a context emphasizing the approximate nature of models.

Aggregate Models, Their Changing Structures and Designs

The record of economics in developing policy models for decision making purposes at the sector and more aggregate levels is anything but distinguished. A number of reviews of the performance of various sector and economy-wide models have come to this conclusion through one avenue or another, e.g., Cromarty and Myers (1975), Crowder (1972), Cooper (1974), Fair (1981), Fox (1973), Haitovsky and Wallace (1972), Hendry (1980), Lucas (1976), Patinkin (1976), Popkin (1975), Rausser and Just (1980) and Tweeten (1975). In general, these and other evaluative studies indicate that performances of economic models have not met the claims of their architects or the anticipations of policy makers. It has been suggested that this failure is due to one or more of the following: insufficient theory, inadequate supply side representations and linkages to the economy at large, failure to update, structural change, unfortunate choices of underlying theory, and poor implementation of the results in policy contexts. Whatever the case, it is clear that economic models are not having a large impact on sector and national level policy decisions. Moreover, not many economists would suggest in good conscience that they should. This is a particularly unfortunate state of affairs in view of the substantial investments in modeling technology, the computer capability for developing and specializing models, and model specifications.

This section reviews model design with respect to four criteria. The purpose is to demonstrate how economists attempting to adapt poorly performing models for use in policy contexts have evolved different methods and practices. These methods and practices are important for more general questions in model design. By tracing their evolution, common themes will become apparent. These themes point to increased recognition that if policy models are to be useful to decisionmakers, designs that reflect the approximate nature of models will have to come to play more directly.

Specification

Model specifications are, of course, motivated by the policy questions at hand as well as hypotheses or theories about the functioning of the system to which the policy is directed. The discussion of the evolution of model specifications and modeling methods begins with the observations by Koopmans (1947) on the measurement without theory. According to Koopmans, measurement of economic relationships is ultimately dependent upon untestable hypotheses about the system. Moreover, he observed that measurements can not be useful unless the untestable propositions on which they depend are specified so that those using the results will understand their underlying restrictions.

Based on this argument and associated statistical developments, simultaneous equations estimation for economic policy models became popular in the 1950s. A number of advances in method followed from this emphasis on model specification and estimation. These related to appropriate estimators for systems of simultaneous equations and useful results on the applicability of such specifications for capturing casuality as hypothesized by the underlying economic theory given the sampling time frames available in the secondary data (Judge, 1977).

Parallel to these developments were advances by agricultural economists and economists which emanated from an input-output conception of the economy (Heady and Egbert, 1959, Heady and Egbert, 1964, Leontief, 1971). These were called normative models because of the optimization rules implicit in their specification and application and focused more heavily on the production function for the economy or sector than on demand side representations. That is, the model specifications emphasized production functions and decisions made around these technical relationships as important for the functioning of economic systems. This was in contrast to market equilibrium models specified at the sector level (e.g., Hildreth and Jarrett, 1955) and the prevailing Keynesian theories at more aggregated levels. For these models the simultaneous equations approach had a major impact.

By the late 1960s, the success record of market equilibrium and input-output models in forecasting and policy analysis had begun to raise important questions. Additionally, more pragmatic approaches to model development had emerged under the general ruberic of systems analysis and simulation (Johnson and Rausser, 1977). The more *ad hoc*, unstructured systems approaches to model development were troublesome for those familiar with more traditional modeling technologies. They were extremely pragmatic. Searching and pretesting for specifications and synthesizing representations of systems were recommended as strategies for model development (Forrester, 1961, Manetsch, et al., 1971).

This adaptive systems approach for model specification forced important adjustments in traditional views on model building. Systems analysis and simulation brought a more pragmatic treatment of economic phenomena and a clearer recognition of the limitations of aggregate model specifications rationalized largely on microeconomic theory. The current more comprehensive and approximate model specifications emerged at least in part as a response by economic modelers to the systems and simulation methods.

Presently, the modeling technology for specifying representations for sector and economy-wide policy analysis is more eclectic. That is, the models have specifications that tend to incorporate essential features of the three approaches; market equilibrium, input-output, and systems methods. Models are market oriented and simultaneous, reflecting equilibrium price determination. They also include restrictions based on production function concepts or input-output information. Finally, simplified representations, largely motivated by the systems analysis and simulation methods, are widely used in bridging between important performance variables and policy instruments. Thus, the general technology for specifying models and policy analyses involves elements of the three approaches identified as influencing specification conventions over the past thirty years.

Statistical Method

Parameters of econometric models specified for policy purposes are typically estimated using statistics which combine sample and other information sources. Early in the 1950s and 1960s, the information used for estimating these parameters was largely sample data, albeit, generated in nonexperimental contexts (Wold, 1969). Although the limitations for applying classical statistical methods in these data were well known, the parameters for statistical models were routinely estimated using these methods.

The pragmatic approaches to identifying parameters in systems analysis and simulation, along with requirements for estimating large scale aggregate models, have resulted in far more flexible approaches to parameter estimation. Prior restrictions and information from different sources now can be systematically incorporated to produce parameter estimates superior to those based on the sample data alone (Judge, et al., 1980). For example, the Bayesian and mixed estimation methods commonplace in the modern applied work are highly flexible with respect to the types of information that can be accommodated to generate parameter estimates (Zellner, 1971, 1979).

The use of Bayesian and mixed estimation methods and different information sources have also served to encourage the development of more flexible norms for evaluating the parameter quality. These are associated with the biased estimation work that occurred in the 1970s and the attention to consequences of pretest estimation. In the former case, trade offs have been recognized between information somewhat inconsistent with the underlying model hypotheses but still capable of providing useful input on parameter values.

The pretest results are particularly important for applied work and, in fact, can be viewed as a response by the statisticians and econometricians to data intensive modeling methods. These results show that the examination of the sample data as a basis of improving model specifications is a highly questionable practice. Claims about the reliability of the parameter estimates for the models, whether econometric or optimizing in nature, based on pretesting are likely greatly over-optimistic. The widespread use of pretesting and the reporting of statistical results for policy models as if such pretesting had not occurred is perhaps one source of the present disillusionment with economic policy models.

There is great pressure on modelers to develop constructs that can predict well within the sample data. The theory is, as a rule, not sufficient to support the specification of models that will produce such predictive accuracy. As a consequence, curve fitting occurs; essentially pretesting in the sample data. Then, results are reported as if the parameters were estimated without pretesting. In such circumstances, the information content of models is grossly over-represented by standard statistics; percent of explained variation, standard deviations, and the like.

In summary, there have been important changes in the types of estimation methods employed for policy analysis models. These changes have served to clarify the limitations of approaches which involve data mining. In general, they show in a somewhat different way, the argument Koopmans (1947) made long ago regarding measurement without theory. That is, unless something is assumed about the model, it takes a great deal of sample data to generate results that will produce predictions or policy analysis constructs that have much information content.

Model Scope

Motivations for expanding the scope of policy analysis models already have been reviewed briefly. It is important that models be sufficiently comprehensive to be predictive on the basis of exogenous or environmental variables that in turn can be reliably projected. Also, representations must be of sufficient size to allow performance variables and linkages to policy instruments to be appropriately modeled. This, together with the fact that researchers are inclined and frequently required to develop models for multiple purposes, along with increased computer technology has resulted in models of increasing scope or scale.

Presently, it is not surprising to find models of the agricultural sector and the economy that include hundreds of equations. That is, the economic constructs are developed which generate as endogenous variables hundreds of characteristics for the system or sector under study. Since these large, nonlinear models can be solved and monitored with modern computer software, they are operationally feasible. They are, as well, attractive to decisionmakers because of the array of performance variables on the systems that can be generated.

Questions remain, however, on whether or not these large constructs are sufficiently well understood to be useful in policy analysis. Also, there are reservations about their forecasting performance. The theory to support large scale models obviously must be developed from multiple and perhaps inconsistent behavioral hypotheses and institutional assumptions. This can lead to pretesting and curve fitting as a means of obtaining "reasonable" structures. The result is models which are impressive in terms of dimension but all too frequently unable to deliver acceptable predictive performance. The prevalence of "wrong signs" in large scale econometric models used in forecasting and policy contexts would be quite surprising to individuals unfamiliar with practices that currently exist in the field.

Approximation Methods

The evolution of approximation methods is the most interesting for the design issues. It is common to make fortuitous choices of sample time periods in estimating parameters for policy models. The result is a model which forecasts well within the sample period and has appropriate signs for the important economic variables. Aggregate annual data are now available for most sector level and economy-wide models from about 1945, constituting a large number of potential sample observations. There is considerable fancy footwork amongst researchers regarding choice of sample period. Frequently, there is little recognition that these choices are essential because their models are approximations. The choice of the sample period is in fact a method of localizing the approximation.

Other more direct methods have been developed for accommodating the evolution of systems are calibration, variational parameters, updating, and disequilibrium modeling. In calibrating, large scale econometric models specifications are adjusted so forecasts are exact for the final sample period. Projections into the future can thus be based on a more "accurate" representation of the system. The model has been localized on the basis of an estimated structure and the most current sample values for the predetermined variables.

Variational parameters were advanced largely as methods for reflecting structural change. That is, when model performance became poor, it was recommended that variational parameters be introduced to accommodate the movement of the model from one regime or structure to another (Rausser, Mundlak, and Johnson, 1981). In this way, the structural change can be endogenized. Unfortunately, the applied experience with variational parameters gives evidence of the limited basis for advancing hypotheses on structural change. Thus, although variational parameters specifications and estimation methods are attractive from an esoteric statistical viewpoint, their impact in applied modeling work has been limited. If a *priori* information exists to permit the representation of structural change by variational parameters specifications, then it should be included in the original specification.

Updating is a different method of adapting models. Updating methods which came to economic modeling in the 1970s were filtering techniques (Kalman, 1960). These filtering techniques provide for efficient linear updating of model parameters. Unfortunately, they do not give guidance on weighting the more recent sample observations. Only if the new sample information happens to be consistent with the structure for the policy exercise in question, can the updating techniques be useful (Sanchez and Johnson, 1981). Thus, the approach of relocalizing approximations through updating methods borrowed largely from engineering has not brought the often advertised benefits. Updating methods are no more than computationally advantageous ways of obtaining the least squares parameter estimates that result from adding linear stochastic restrictions to the existing sample data.

Finally, the disequilibrium methods in econometrics should be mentioned. These methods are essentially ways of statistically closing among model representations. Several possible regimes are specified. Based on parametric assumptions, the estimation process selects regimes most consistent with the sample data (Richard, 1980). Predictions then can be made using variables assumed to condition the regime as in the case of varying parameters specifications. For localization of models viewed as falling into sets of regimes, these disequilibrium methods can be useful. Of course, availability of the prior information on the regimes is the crucial factor for these methods.

Promising Developments in Model Design

The models presently available for policy analysis for the agricultural sector and for the economy are surprisingly homogeneous in design. With some exceptions, e.g., CARD (Huang, Weisz, and Heady, 1980) and POLYSIM (Ray and Richardson, 1978), the models are econometric simultaneous equations constructs. For example, the USDA (Baumes and Meyer, 1979), Chase, DRI, and

Wharton models of the agricultural sector are nonlinear equation systems, at least in part simultaneous. Similar designs are used for the existing economy-wide models, e.g., Fed-MIT (DeLeeuw and Gamlich, 1968), Wharton (McCarthy, 1972), DRI (Eckstein et al., 1976). These economy-wide models have been reviewed recently for performance by Klein and Burmeister (1975).

Most of these large scale models are estimated with single equation methods that do not reflect simultaneity or mean square error norms. Specifications have evolved from substantial curve fitting and attempts to incorporate poorly rationalized theoretical constructs. Updating methods are ad *hoc* and opportunistic and, in general, not advanced on a strong a *priori* base whether in terms of the model specification or the process generating the disturbances. Finally, the results from the models are difficult to communicate to individuals at policy levels. This is because the structures are complex and simplified representations are not available. Still, however, there are encouraging developments.

Model Specification

Developments in model specification have occurred more as a consequence of applying existing model representations than revelations in the theory. At the aggregate level, theoretical developments of practical import have been rather slow in coming. While there has been important work on micro foundations of macro relations, aggregation problems, available sampling time frames, and problems of approximating the equilibrium conditions at aggregate levels, have made it difficult to incorporate the results into model specifications. Instead, the directions in model specification have occurred more in response feedback from users. That is, users have required that models accommodate expanded sets of policy variables. Also, the forecasts obtained from the models have been under question. These two concerns and the problem of communicating the complex structures have led to interesting changes in model specification.

The first of these changes involves the willingness of the econometric modelers to incorporate judgmental information. Judgmental information systematically obtained and introduced into model specifications and estimation processes is particularly important for guidelines on design. Methods for eliciting judgments on parameters and troublesome variables are well developed (Hampton, 1973, Hendrickson, 1972, Hogarth, 1975, Savage, 1971, and Winkler, 1967, 1969, 1971). Also, mixed estimation methods can be used to incorporate this information in particular estimation or forecasting contexts (Johnson and Rausser, 1981).

The use of judgmental input is advantageous because the processors which generate this information are typically far more adaptive than those represented in the econometric model. Judgments are influenced by information bases different than the data bases on which estimated models reside. Also, judgmental input is processed with a far more adaptive structures. Thus, in areas where judgmental input is used, more simplified models can be utilized. Model specifications do not have to be stretched beyond the theory to encompass events that can be represented by judgmental input.

A second change in model specification involves rationality. In general, rationality hypotheses can improve the behavioral consistency of the model specifications. Expectations variables are important arguments in many econbmic relationships. Expectations have been introduced by various methods ranging from lagged relationships to observed data (Nerlove, 1972, Gardner, 1976). The rationality hypothesis states that expectations must be generated from a structure consistent with that implied by the model for the corresponding endogenous variable (Muth, 1961, Simon, 1979).

Methods for incorporating rational expectations in large scale econometric models have received increased attention (Chavas and Johnson, 1981, Grossman, 1977, McCafferty and Driskill, 1980, and Taylor, 1977). The upshot of the developments on expectations incorporation and their existence in nonlinear structures shows that the impact of rationality is highly dependent on the ability to project the environmental or exogenous factors. Thus, through attempts to improve specification, a direct link has been made to the basic conceptual problem of formulating models sufficient in scope that the environmental variables can be accurately projected. Where this is not true, rationality may imply expectations determined by structures are not the same as those implied by the model structure (Chavas and Johnson, 1981). These observations suggest that model specifications should be no more complex than can be justified by the resolution possibilities for the environmental factors.

Still another change with implications for model scope has followed from forecasting problems (Feldstein, 1971, and Fair, 1980). Analyses of the forecasting potential for econometric models have concentrated on the uncertainty transmitted from the environmental variables. Again, the emphasis is for models sufficient in scope to accommodate the uncertain environmental variables. Unless these uncertain variables can be incorporated, rationality does not require complex specifications (Simon, 1979). This more realistic approach to forecasting performance adds to arguments against unstructured, opportunistic methods for specification and application of econometric models.

Finally, model specification has been influenced by examining the information content of the sample. The implication is to modify model specifications, localizing them so that they do not demand information not available in the sample. The information content of the sample is determined by the implicit experimental design. By examining the implicit experimental design, two important results for model specification can be obtained. First, the viability of the existing structure for accurate prediction, ignoring the uncertainty associated with the environmental variables, can be determined (Sanchez and Johnson, 1981, Guttman, 1971, Kiefer, 1958, MacRae, 1977, Covey-Crump and Silvey, 1970, Silvey, 1969, and Wynn, 1970). By examining the implicit design matrix, the possibility of the specification for generating reliable forecasts or predictions or identifying reliably effects of policy instruments on the performance variables can be determined. Second, decisions can be made on the value of extra-sample information for particular policy situations. This result is especially useful in the case of incorporating judgmental input (Johnson and Rausser, 1981).

To summarize, these developments in aggregate model specification appear to have been triggered largely by more carefully assessing the potential of samples for providing reliable parameter estimates given the model specification. Encouragingly, changes in specification have been prompted by attempts to improve on the behavioral consistency of models. Finally, the forecasting potential of the models has been more realistically examined. It would be fair to say that the full effects of these changes have not been felt. This is especially clear if one sees the model specification process as one obtaining a usefully local approximation.

Adjusting Approximations

As already mentioned, the most common method for adjusting model approximations is through the use of calibration methods.

That is, adjusting the model so that the forecast is accurate within the last sample period and then making projections into the future. Alternative ways of adjusting the approximations are, however, becoming available. Composite forecasting can be seen as a method of adjusting the model approximation (Johnson and Rausser, 1981, Falconer and Sivesind, 1977, Granger and Newbold, 1977, and Bessler and Brandt, 1979). This is observed by considering the econometric model as a fixed parameter construct based on existing sample data and the model from which the alternative forecast is generated, perhaps a judgment or futures market outcome, as one with variable parameters and an adaptive specification. By using the composite forecast, a more adaptive or adjusted approximation is available. That is, the fixed approximation represented by the econometric model is augmented with input from a more adaptive forecasting process.

Approximation methods are also becoming better developed for nonlinear representations. Economists are recognizing that it is necessary to approximate the aggregate, nonlinear models for use of their results in policy analysis and forecasting. Evidence of this is contained in improved results on the identification of impact multipliers for the conditioning variables (e.g., Brissimis and Gill, 1978, Chow, 1975, Fair, 1980, Sowey, 1973). For nonlinear and complex representations, the identification of these effects and the study of their behavior can be viewed as a way of localizing model results. These localized versions of the models can then be moved or altered depending upon the state in which the system is observed. Using these approximation methods, seemingly complex model structures can be represented in a communicable form.

Also, interestingly, these approximation methods and the ways of applying them indicate approaches for developing far more direct local model specifications. That is, one is led to ask, what is the gain that occurs as a result of estimating complex nonlinear models if the information from them must be summarized utilizing local approximations? Could not the local approximation simply be used to represent the system at large? If so, then model designs could be much more flexible; linear approximations localized based upon the observed levels of the environmental variables for the system.

Approximate Specifications

The results from the above observations on present model specifications and the general framework for model design advanced in this piece, are relatively straightforward. At the aggregate level at least, economists are working with models that are false or approximations to true systems (Leamer, 1978). The theory, given the level of aggregation, can do little more than suggest a causal structure and the arguments of functions. Clearly, the economic theory of aggregate models is, in general, not sufficient to suggest specifications of functional form.

This observation on the richness of the theory relative to the applied problems of modelers has far-reaching implications. Specifically, if we follow through, using linear specifications (in the absence of a basis for more complex ones), the result is approximations that are extremely local. Again, the locality of these approximations has led researchers to engage in curve fitting as a basis for generalizing the representations. This curve fitting mines the sample data and, in most cases, produces specifications that are highly specialized to the nonexperimentally generated design matrix. If the problem of localization for structures is deferred to other methods or approaches and the economic models are specified conservatively *vis-a-vis* the theory, relatively uncomplicated representations are implied.

The recommendation, therefore, is that the models not be aggressive in theoretical content. Only well developed theoretical and empirical results should be introduced in the specification process. The concern for evaluating specifications should be more with respect to signs than with prediction. Predictability concerns can be left to the localizing mechanisms. In short, an understandable and limited local approximation can be specified. It is not necessary to complicate this specification to improve the predictive performance of the model. The predictive performance as the model moves from one locality to another can be assured by proper use of localization methods.

Implications of these observations are for models with less demanding constructs. These models are more easily understood by policymakers and not unimportantly, by the researchers themselves. With more simple models it is possible to trace effects of perverse signs and to use specifications that can generate quantitative information that is more consistent with the theory. Lastly, the substance of the theory supporting the specification can be communicated to those who utilize the results.

Localization

Suppose now that an approximate model has been specified. This model is conservative with respect to the theory and will likely produce estimates which are not impressive in terms of traditional validation schemes and the ability to predict outside the sample data. The localization or adaptive schemes for making the model predictable are generated outside the economic model specification. Two approaches for making these adjustments are discussed in this section. One involves the combining of models. The other is a direct reestimation scheme.

Combining the Models

When estimating structural equations in econometric models, a number of diagnostics are usually applied. One purpose of these diagnostics is to test for patterns in residuals. Where patterns are evident and can be reflected using autoregressive moving average processes, these patterns are frequently incorporated in estimating the structural equations. The estimated structure is then solved for a reduced form and forecasts are made.

The problem with this process is that autoregressive moving averages in the residuals also can occur across equations. It is well-known that the forecasts from models with such autoregressive specifications should include the information on the process generating the residuals. Thus, the forecasts from econometric models where autoregressive moving averages are suspected or detected in the residuals should contain the information from this *a* priori specification as well as from the structure.

There are two methods for incorporating this information on the process generating the residuals. These are illustrated in Figure 1. The first is structural and by comparison generates a restricted reduced form specifications for the residual processes. The economic structure is specified and estimated. At the same time, a multivariate process is estimated for the residuals on the structural equations. Then a solution for the reduced form is made with the implications of the *a priori*, perhaps exclusion restrictions, imposed on the reduced form residual process.

A second method is simply to estimate the structure, perhaps with the incorporation of important autoregressive moving average effects for specific equations. Then a solution is made for the reduced form implied by the economic structure. An unrestricted estimator of the autoregressive moving average process on the reduced form residuals is then estimated. Forecasts then involve two components. The first component is from the restricted reduced form estimator for the systematic component of the model. The second is the unrestricted reduced form estimator for the residuals.

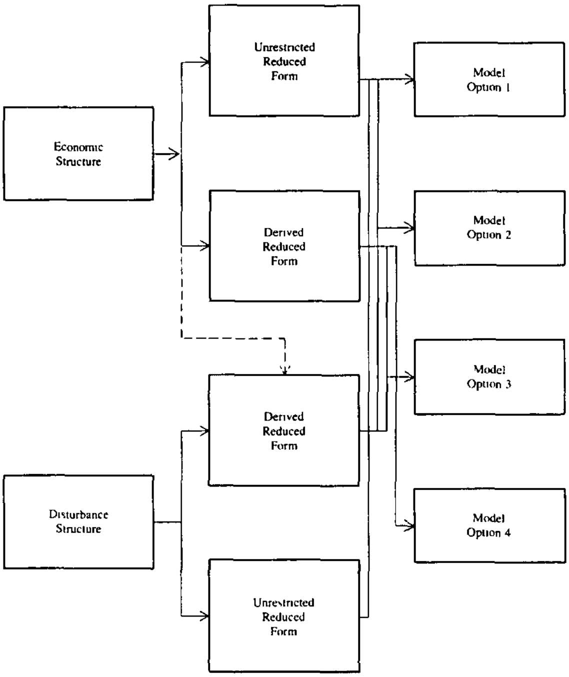

FIGURE 1. Combining Economic and Time Series Models.

These combined models can be viewed as methods for localizing approximate structures. The localization factors are derived from a fixed parameter representation of the residual process. That is, structural parameters are estimated from the time series data. Then either in a restricted reduced form or an unrestricted reduced form mode, the fixed parameter specifications for the autoregressive moving average processes on the residuals are estimated. Finally, the system is localized in a time series context by adjusting the values for the endogenous variables to reflect the information contained in the residual process. Standard methods of calibration can, in fact, be rationalized based on this approach (Johnson and Rausser, 1981a).

The advantage of the residual process based approach to the localization of econometric models is that no violation of the theory is necessary to generate models with satisfactory predictive content. Autoregressive moving average processes, abstracting from computational difficulties associated with the multivariate specification, can be used to approximate series on endogenous variables until they include only white noise (Box and Jenkins, 1976). The same is, of course, true for the residuals based on the observed values of the endogenous variables as compared to the forecasts or projected values based on the estimates of these variables generated from the structural model. Thus, the forecasting accuracy of the model is not at issue. Instead, the issue is the partitioning of the process for generating the forecast as between a specification motivated by economic theory and a specification which is motivated by the desire to appropriately localize the model.*

Re-Estimation

The advance of computer technology has made the problem of calculating parameter estimates for econometric models or systems of equations comparatively inexpensive. Parameters of models are easily recalculated on different data series or interestingly, the choice of different loss functions. This has led econometricians to begin to think of localized or sufficient linear approximations to systems. Approximations are made depending on the state in which the system resides, usually determined by the values of the environmental variables. Although work in this area is at a beginning stage, there are results that suggest the general thrust of the research (Gourieroux and Monfort, 1980, Hendry, 1980a, Monfort, 1975, Richard, 1980, White, 1980, and White, 1979).

The theory for these approximation approaches is, in general, straightforward. That is, one can think of an adapted approximation to a complex system, Figure 2. Sample information is summarized to specialize this approximation so that it generates the most useful

***To be sure, this approach can be rationalized in a varying parameters context, broadly conceived. The separation in this instance is motivated by the concern with separating the theoretically derived structure from one which has as its objective improving predictive performance for applied purposes.**

forecasts. For example, forecasts might depend most heavily on the experience with the system in states similar to the one in which policy analysis is to be conducted. One method for choosing this approximation is to pick between regimes. Another is to let the sample data adjust the parameter values depending upon weights generated from the implicit design norm.

Suppose an implicit design matrix is reflected in a norm that makes it possible for the parameter estimates to be specialized to the forecast or policy problem at hand. The specification can be accomplished by specifying the position of the system (in terms of values of the conditioning variables) in which the policy exercise or forecast is to occur. Then, estimation of the parameters can proceed with the sample data and a loss function related to the distance of the observations (or another measure of locality) from the point to which the information on the model is to be focused.

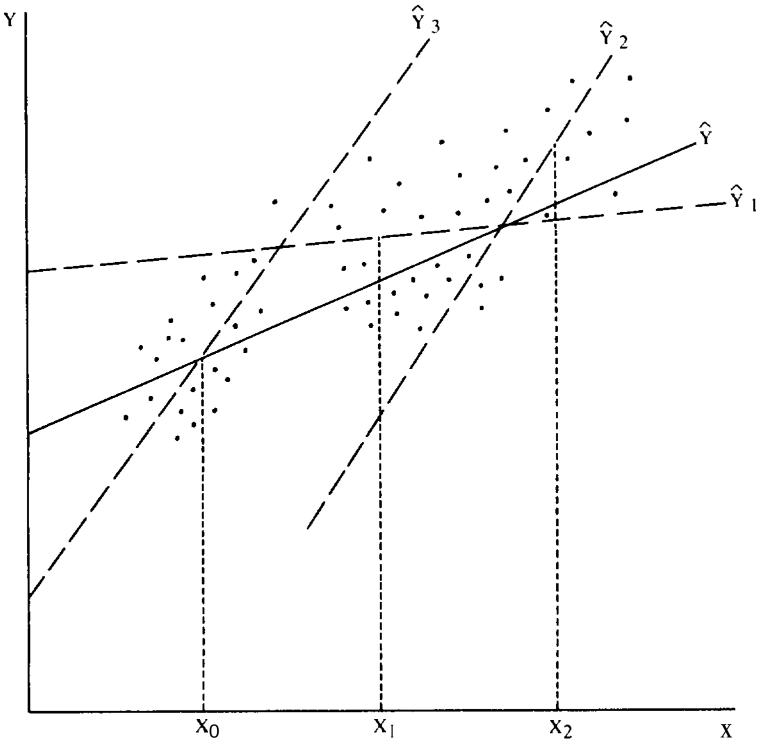

FIGURE 2. Localizing Parameter Estimation by Weighting Sample Data.

Using this approach, the experiences in the sample period most consistent with the exercise to which the model is to be put are weighted most heavily for calculation of the parameter values. Thus, different estimates of the parameters are implied by different forecasting problems and different policy analysis requirements. The intent is to move the local approximation of the complex system so that it is more accurate given the sample information available.

Straightforward computational procedures can be developed for this localization process. Values of the standard errors for the parameters computed for localized models provide an idea of the reliability of the results for specific policy analyses. That is, the estimated standard errors provide information on the uncertainty about the parameter estimates given the region in which the model is localized. For example, if there is a great deal of information in the sample about the system in the state or locality to be studied, then the parameter estimates will be highly reliable. The converse is true if the experience residing in the sample is thin. Thus, an approach of calibrating, or localizing the models is available by recalculating the parameters. This direct method makes the localization process apply to parameter estimation.* That is, the estimation process is one which implicitly incorporates an hypothesis about localizing the model.

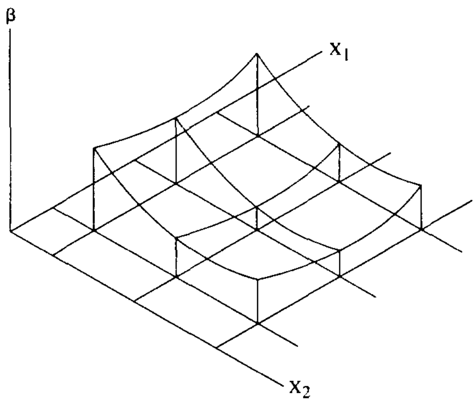

FIGURE 3. Response Surface in Estimated Parameter Values Based on Design Point Weights.

***It may be of interest to view this process in a varying parameters context. Instead of adding *a priori* information about the economic factors responsible for the change, parameters are altered by *a priori* information on the weighting of the sample observations.**

Re-Estimation and Combined Models

Examination of the residuals from the re-estimated model for the sample data is readily accomplished. These residuals can be examined using the same kinds of time series processes as discussed for combined models. Based on the examination of these residuals, as illustrated in Figure **3,** it can be determined whether the localization provided by the re-estimation at each of the sample points has removed sufficient variation. Also, since the localization does not have to be at the sample points, experimental designs in the underlying variables can be examined for impacts on parameter estimates. However, the results of the localized parameter estimates calculated for these experimental design points can not be compared to the sample data. The problem is, of course, that the residuals do not exist. Thus, residuals can be calculated based on the results of the localized estimators where the localization occurs at sample points.

Alternatively, the experimental design can be specified in the exogenous variables. The experimental design can be suggested by the forecasting and policy uses intended for the model. Then, the parameters at the design points can be estimated. The values of these parameters then can be examined as they vary over the design space. Methods for examining the parameter estimates as they vary over the design space can employ be the same autoregressive moving average processes suggested for analysis of the residuals. The stability of the parameter estimates can be analyzed. Alternatively, the estimated structures showing how the parameters vary over the design space can be used for adjusting the parameter values of the model depending on the situation to be studied.

Evaluation and Alternative Designs

The major points of the discussion of alternative designs and model performance are the separation of the processes of specifying a model which is appropriate based on the existing theory and the achievement of satisfactory predictive content for applied policy analyses. This separation may appear unconventional given that the ultimate validity of models is determined by predictive content. On the other hand, the conclusions are consistent with those common in research methodology (Popper, 1968 as compared to Kuhn, 1970). One should identify on the basis of theory, models which have the greatest predictive performance. But predictive performance not being absolute is relative to that available for other models or theories. Once a specification choice has been made on the basis of relative predictive performance, the model can be fitted for use in applied situations.

Applications of policy models require high levels of predictive performance. If the theory is weak, then specifications with no economic content will have to be heavily relied upon to achieve adequate predictability. Autoregressive moving average processes are a logical supplemental choice in this connection. Using autoregressive moving average models perhaps combined with re-estimation of parameters for the economic model based on the implicit design matrix, specifications with various theoretical bases can be fitted for use in practical contexts. The choice criterion in model design is based on the relative amount of the variation which can explain with the economic or conceptual component of the structure. Nothing is changed relative to the traditional way of viewing model design. It is simply that the question of theoretical validity of the models is determined by relative predictability and the use of the models is governed by ultimate predictability.

With the approach emphasizing relative predictability in model design, econometricians and other modelers can escape traps associated with the mining of sample data, curve fitting, and the use of constructs which employ calibration or adjustment mechanisms that are indefensible to the ultimate users. There is justification for discerning among different theoretical model specifications and for approaches to localizing these models. The paper has had as its objective separating the localization from the theoretical specification questions and recommending approaches for the latter of these processes. It has been argued that by not recognizing this distinction, all too often econometricians and other modelers have moved into self-defeating approaches to model design. They have developed models which are not useful for predictive purposes and of little value to policymakers because the structures are so complex and so far removed from explainable theory that even the econometricians themselves do not believe them.

Finally, a comment is in order based on several older econometric pieces. What this reference shows is that, although we have developed substantial computational capability and information about the quality of estimates for fixed parameter structures, little has been done to better rationalize processes for dealing with approximate specifications in realistic contexts (Keynes, 1939, Patinkin, 1976, Orcutt, 1952 and Schumpeter, 1933). The proposed approximation-localization approach and the associated discussion of model design provide an intuitive way out of the theory-predictive content dilemma, making it possible for economists to apply good theory to realistic problems with the prospect of providing useful results for policy.

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