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POLICY PREFERENCE FUNCTIONS: GRAND THEMES AND NEW DIRECTIONS

by

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Policy Preference Functions:

Grand Themes and New Directions

Abstract

Policy preference functions (PPFs) explicate trade-offs among various political economic groups concerned with the policy process. Estimation methods for PPFs are detailed. The stochastic nature of PPF parameters is discussed and a method for developing standard errors is introduced. Hypothesis testing and model validation techniques are also covered.

Policy Preference Functions: Grand Themes and New Directions

Much progress has been made over the last decade or so on the study of the agricultural policy process. The profession has slowly come to the realization that political and economic markets are integrated, that first-best solutions are not achievable, and that lump-sum transfers envisioned by standard welfare economics are not possible. In these emerging developments, the conceptualization of a policy preference function (PPF) (Rausser and Freebairn) has played a crucial role.

Specifically, a PPF makes explicit the implied trade-offs, or relative weights, among various political economic groups concerned with the policy process. Also defined as policy criterion functions (Love), governing criterion functions (Rausser and de Gorter) and political preference functions (Rausser and Foster), the PPF can be a useful tool for explaining policy selections, predicting future policy paths and normatively evaluating alternative policy reforms.

Unfortunately, the PPF framework has been largely conceptual, with very little formal empirical analysis. This is understandable, given the number of unobservable variables that arise in political-economic markets (Rausser, Lichtenberg and Lattimore). Nevertheless, for science to progress, refutable hypotheses must be formulated and empirically investigated. Accordingly, this paper focuses on: 1) a general model for political-economic behavior of agents and policymakers, admitting refutable inferences; 2) methods for estimating probability distributions for preference weights allowing discrimination across different theoretical formulations; 3) empirically testing well formulated hypotheses; and 4) a number of validation tests for determining the reliability of any empirically constructed PPF. The paper is organized around these four themes: a generalizable PPF model, empirical methods for constructing PPFs, the use of statistical methods to estimate the unknown weights in the PPF, and various validation techniques.

Generalized PPF Model

Government behavior has historically been neither completely predatory, as modeled in the public choice literature, nor totally benign, as portrayed in the social welfare literature (Rausser 1990). The social welfarist approach presumes that governments act to improve allocative efficiency through collective action. In contrast is the view of government as predator, serving rent-seekers and the politically strong, in which all power rests with special interests (Buchanan and Tullock; Bhagwati). In reality, both motives shape the formulation of government policy. Any useful analytic framework must include these two extremes, admitting both government benevolence and pursuit of self-interest by all political-economic agents, as well as provide a basis for operational prescription.

A policy preference function (PPF) framework is an integrated approach. Specifically, a PPF explicates the implied trade-offs among various political-economic groups concerned with the policy process:

(1) $W_t = W_t(b_{it}, s_{it}(x_t, z_t; g_t))$,

where W_t is a political-economic performance measure, $s_{it}(\ )$ is the performance measure of agent group i, b_{it} is the weight on group i's performance measure, x_t represents policy variables, z_t represents other endogenous variables, and g_t represents exogenous variables. Performance measures can be expressed as money or utility metrics or as indicator variables. A time subscript t denotes that the function may change over time. Weights are determined through political-economic gaming among interest groups and government. There is one performance measure $s_{it}(\ )$ for each player. If i=0 is the policymaker (PM), s_{0t} is the government performance measure and special interest groups are identified i=1 to n.

The PPF is maximized by the PM subject to economic constraints

(2) $z_t = F_t(x_t, z_t; g_t)$,

where $F_t(\ )$ represents the economy at time t and structurally incorporates the policy instruments (e.g. Lee and Helmberger's model of acreage allocations).

Exogenous variables g_t are all which are not internally set by the model, and include any lagged endogenous variables, z_{t-1}, or policy instruments, x_{t-1}. Strictly exogenous variables include certain economic variables, characteristics of interest groups, and policymaker preferences.

Interest Group Objectives

Interest groups must be defined within the context of the policy problem. In analysis of domestic agricultural programs, some obvious interest group designations are consumers, farmers, taxpayers, and political action committees (PACs). Omission of an interest group implicitly assigns a zero weighting to the performance objective of that group. Political economic agents are not limited to participation in only one interest group. Farmers are also consumers of agricultural products and many people contribute to more than one PAC. The welfare benefit derived as a member of one group is in addition to, or is offset by, welfare derived as a member of other groups.

The $S_{it}(\ )$ function represents the objectives of interest group i at time t, composed of like-minded political economic agents, and is expressed in terms appropriate to those goals:

(3) $S_{it} = s_{it}(x_t,\ z_t;\ g_t) - c_{it}$

where $s_{it}(\ )$ is the performance measure of interest group i and c_{it} is the cost of power for group i. S_{it} is analogous to a political profit function in that rewards of political action $s_{it}(\ )$ are reduced by expenditures on political effort c_{it}. The choice variable is c_{it} for each interest group i = 1 ... n. Each c_{it} implies a level of support for a politician, which affects the PM's choice of policy x_t. Variable c_{it} represents costs of political power and is generally not observable. Political costs include organization costs for the interest group, lobbying costs, and costs of coalition building. They include direct money outlays and opportunity costs of time.

The functions $s_{it}(\ )$ for i = 1 to n represent performance measures of interest group well-being. Choices of measures include economic surpluses or other measures of economic well-being such as welfare-ratios (Blackorby and Donaldson). Policy instruments themselves may be included as goals if they are important to the interest group. For example, farmers may prefer the complex deficiency payment system for some crops over a lump-sum payment system giving them the same dollar amount because they wish to maintain the illusion that deficiency payments are earned. Explicit specification of policy instruments in the objective allows such preferences to be expressed within the context of the model. Additionally, interest groups may care about the general economy; political groups may be concerned with unemployment, interest rate levels or environmental indicators.

Exogenous variables g_t relevant to interest groups are group size, group organization factors, and the asymmetry of benefits and costs within the group (Olson; Peltzman; Stigler 1971, 1974), geographic dispersion (Olson; Ferejohn and Rundquist; Weingast, et al; Lipton), ideology, political party, and group personality (Kalt and Zupan; Peltzman). Laws and institutions affect all players (Williamson) and play a role determining the weights b_{it} (Rausser and Zusman).

Policymaker Objectives

The PM is an abstraction, representing an array of government bodies. In some cases, one or more government agencies may be best classified as an interest group. For example, in analysis of environmental policies, the federal government may be the PM and state and local government constitute interest groups. The PM pursues his self-interest, which may include maximizing his probability of remaining the PM. If the PM is a government, this corresponds to choosing policies to suit his own preferences as well as to maximize political support generated by various interest groups (Rausser 1990; Zusman).

$$(4) \quad S_{0t} = s_{0t}(x_t,\ z_t;\ g_t) + \sum_{i=1}^{n} p_{it}(c_{it},\ \delta_{it}(c_{it});\ g_t),$$

where $s_{0t}(\ )$ is the performance measure of the PM at time t; $p_{it}(\ )$ is the political power function of the ith group; c_{it} is the cost of accruing and exercising political power for group i; and $\delta_{it}(c_{it})$ is the strategy pursued by that interest group as a function of costs. A group's strategy may consist of lobbying efforts or perhaps an advertising campaign, but is denominated in the costs of the chosen approach to preserve the money metric. The PM's choice variable is x_t, which affects each interest group's choice of c_{it}. If government has all the power, the PM is a benevolent dictator, $s_{0t}(\ )$ is defined as pure public interest, and special interests are unimportant, the PM chooses x_t to maximize social welfare. Thus, a social welfare function is a special case of a PPF.

For the policymaker, the function $s_{0t}(\ )$ combines policymaker preferences and other items of importance to the PM, such as the deadweight loss and treasury costs associated with policy implementation. In the case of an autonomous PM who does not have to face election, e.g. the Chairman of the Federal Reserve, the function $s_{0t}(\ )$ and PM preferences might be quite important while the $p_{it}(\ )$ may be less relevant. Incorporation of policymaker preferences sharply contrasts with Becker and Peltzman, both of whom model the PM as a kind of policy Walrasian auctioneer, serving to clear the political market without imposing any identifiable influence on the result.

The political power function $p_{it}(\ )$ and strategy variable $\delta_{it}(\ )$ are specified in accordance with the political dynamics as perceived by the policymaker. The strategy variable measures interest group intent while the political power function measures the PM's perception of interest groups' political impact; both are unobservable. $p_{it}(\ )$ does not necessarily have the same sign as $\delta_{it}(\ )$. When $\delta_{it}(\ ) > 0$, the strategy is to support the PM at some level $\delta_{it}(c_{it};\ g_t)$, so that each level of support strategy implies some cost c_{it} to the interest group, given exogenous variables g_t. When $\delta_{it}(\ ) < 0$, the strategy is to penalize the PM by working against him or by supporting the opposition. When $\delta_{it}(\ ) = 0$, political abstinence is implied. However, $\delta_{it}(\ ) = 0$ does not imply that $c_{it} = 0$ or that $p_{it}(\ ) = 0$. One specification of these functions is detailed in Zusman.

The Generalized PPF

The generalized PPF model is developed from maximization of the governing criterion function of a political-economic game subject to constraints, equations (2), (3) and (4). Political dynamics become embedded in the resulting policy preference function to leave the policymaker with the following problem:

(5) $$\max_{x_t} W_t = W_t(\ b_{it}(p_{it}(\ ),\ c_{it}),\ s_{it}(x_t,\ z_t;\ g_t)\ ),$$

subject to economic constraints, equation (2). Equation (5) is a generalized policy preference function, representing a modification of equation (1) to include endogenous determination of b_{it}. Separability of performance measures and political variables in equations (3) and (4) allows weights b_{it} to be distinct from $s_{it}(\ )$. The weights and functional form of equation (5) then reflect the social power structure and objectives of various interest groups in addition to the PM's own preferences.

To see how political dynamics affect a PPF's functional form, consider a Nash-Harsanyi cooperative game where the solution is to maximize the product of gains in performance objectives over their corresponding initial values[1]:

(6) $$\max_{x_t,\,c_{it}} G_t = \prod_{i=0}^{n} [\ S_{it} - S_{it-1}\ ],$$

subject to equation (2), the economic constraints; equation (3), the interest group objectives; and equation (4), the policymaker's objective. S_{it} is the level of group i's objective and S_{it-1} is the initial level of group i's objective measure, for i = 0 to n.[2] By taking logs and making the appropriate substitutions, equation (6) can be rewritten:

$$(7) \quad \max_{x_{kt}, c_{it}} \ln G_t = \ln \left[s_{0t} \left(x_t, F_t \left(x_t, z_t; g_t\right); g_t\right) + \sum_{i=1}^{n} p_{it} \left(c_{it}, \delta_{it}(\ ); g_t\right) - S_{0t-1} \right] + \sum_{i=1}^{n} \ln \left[s_{it}(x_t, F_t(x_t, z_t; g_t); g_t) - c_{it} - S_{it-1}\right],$$

Resulting first order conditions (FOC) are multiplied by $(S_{0t}^* - S_{0t-1})$, where "*" indicates optimized value, to get:

$$(8) \quad \frac{\partial G_t}{\partial x_{kt}} = \frac{\partial s_{0t}}{\partial x_{kt}} + \frac{\partial s_{0t}}{\partial F_t}\frac{\partial F_t}{\partial x_{kt}} + \frac{\partial s_{0t}}{\partial F_t}\frac{\partial F_t}{\partial z_t}\frac{\partial z_t}{\partial x_{kt}} + \sum_{i=1}^{n} \frac{(S_{0t}^* - S_{0t-1})}{(S_{it}^* - S_{it-1})} \left[\frac{\partial s_{it}}{\partial x_{kt}} + \frac{\partial s_{it}}{\partial F_t}\frac{\partial F_t}{\partial x_{kt}} + \frac{\partial s_{it}}{\partial F_t}\frac{\partial F_t}{\partial z_t}\frac{\partial z_t}{\partial x_{kt}}\right] = 0,$$

for policy instruments k = 1 to K, and

$$(9) \quad \frac{\partial G_t}{\partial c_{it}} = \frac{\partial p_{it}(c_{it}, \delta_{it}(\ ); g_t)}{\partial c_{it}} - \frac{(S_{0t}^* - S_{0t-1})}{(S_{it}^* - S_{it-1})} = 0,$$

for interest groups i = 1 to n. Equation (8) represents FOC which can be recovered from maximizing a PPF of the form

$$(10) \quad W_t = \sum_{i=0}^{n} b_{it}\, s_{it} \left(x_t, z_t; g_t\right),$$

with respect to the policy instruments x_t where $b_{0t} = 1$ and the other b_{it} are

$$(11) \quad b_{it} = \frac{S_{0t}^* - S_{0t-1}}{S_{it}^* - S_{it-1}} = \frac{\partial p_{it}(c_{it}, \delta_{it}(\ ); g_t)}{\partial c_{it}},$$

which derives from equation (9). The functional form and weights in the PPF result from the game solution.

Players in the cooperative game jointly maximize gains G_t. Optimal choices of c_{it} and x_t are simultaneously determined and are reflected in the topology of the policy preference surface. Values of c_{it} different from those chosen optimal imply a different set of PPF weights b_{it}. Thus, PPF maximization by the PM with respect to policy instruments x_t is conditional on the c_{it} chosen in the game. Figure 1 illustrates the structure of the PPF maximization problem. For a stable equilibrium, the policy preference surface must be quasiconcave in performance measures. Iso-policy preference curves (IPPCs) are drawn on the policy preference surface, over which policy preference level is held constant across distributions of performance measures. Equation (2) determines an economically feasible set, bounded by a performance measure transformation frontier (PMTF). The PMTF is analogous to a utility transformation curve (Samuelson) and a surplus transformation frontier (Gardner 1983). The feasible set is concave to the origin, as in figure 2. The PMTF is tangent to the iso-policy preference curve at optimal point H, defined by $(x_t^*, z_t^*, g_t^*, c_t^*)$. Point H is revealed preferred to any other point on the PMTF and is identifiable through observed variables (x_t^*, z_t^*, g_t^*) where c_t^* is incorporated into the curvature of the policy preference surface.

Alternative game solution concepts result in different PPF specifications. Comparing b_{it}'s in equation (11) with those resulting from a utilitarian game, where the solution is the summation of player objectives, illustrates this point:

$$(12)\quad \max_{x_{kt},\, c_{it}} \quad G_t = \sum_{i=0}^{n} S_{it},$$

yielding first order conditions

$$(13)\quad \frac{\partial G_t}{\partial x_{kt}} = \frac{\partial s_{0t}}{\partial x_{kt}} + \frac{\partial s_{0t}}{\partial F_t}\frac{\partial F_t}{\partial x_{kt}} + \frac{\partial s_{0t}}{\partial F_t}\frac{\partial F_t}{\partial z_t}\frac{\partial z_t}{\partial x_{kt}}$$

$$+ \sum_{i=1}^{n} \left[\frac{\partial s_{it}}{\partial x_{kt}} + \frac{\partial s_{it}}{\partial F_t}\frac{\partial F_t}{\partial x_{kt}} + \frac{\partial s_{it}}{\partial z_t}\frac{\partial F_t}{\partial z_t}\frac{\partial z_t}{\partial x_{kt}} \right] = 0,$$

for instruments k = 1 to K and

$$(14)\quad \frac{\partial G_t}{\partial c_{it}} = \frac{\partial p_{it}(c_{it}, \delta_{it}(\ ); g_t)}{\partial c_{it}} - 1 = 0,$$

for each interest group i. Equation (13) is the FOC resulting from a PPF of the form of equation (10) with b_{it} set to 1, for i = 0 to n. Weights in this utilitarian game are equal, while weights in the Nash-Harsanyi cooperative game are equal only where the game results in equal gains for all players--a situation indistinguishable from the utilitarian solution.

There are many alternative models of political economic behavior: voting markets (e.g. Abler), constitutional consent (Buchanan and Tullock), median voter (Romer and Rosenthal), bureaucracy (Niskanen), cooperative political games (e.g. Harsanyi; Riker; Aumann and Kurz), economic regulation (Stigler 1971, 1974), pressure groups and influence (Peltzman; Becker; Zusman), and hybrid models that include more than one of these elements (e.g. Rausser and de Gorter, Rausser and Foster, and Gardner 1987). Each theory implies a different PPF specification. An interesting research question is whether the data support one representation over all others.

Empirical Applications of PPFs

Empirically estimated policy preference functions typically derive relative weights b_{it} without specification of an underlying political structure. That these weights are in fact reduced form estimates is not widely understood. The use of reduced forms is necessary because political variables are generally unobservable.

There are three general approaches to obtaining reduced form weights in a PPF (Rausser and Freebairn). These are: the direct approach, consisting of interviews with policymakers to make weights explicit; the indirect approach, also known as the revealed preference method, in which recent policy decisions are assumed to optimize the PPF subject to appropriate constraints so that policy preference weights can be inferred; and the "arbitrary" approach, in which the researcher simply chooses policy weights according to his own beliefs.

Direct and Arbitrary Approaches

Consider first the direct interview and arbitrary approaches, which have been employed by Coomes; Van Eijk and Sandee; and Panattoni. Both of these approaches result in weights b_{it} being set in a manner which is difficult for an objective reviewer to assess. Thus, the usefulness of the arbitrary approach for policy setting and evaluation is limited.

The interview approach elicits PPF weights directly from the PM. The identity of the policymaker or set of PMs may be difficult to ascertain. Interviewer bias may affect questions and answers, or the PM may be unable to articulate preferences (Rausser and Freebairn). In a game theoretic framework, the PM may not want to reveal his policy preferences because such revelation may affect the outcome of policy implementation (Kydland and Prescott).

The Indirect Approach

The indirect approach assumes policies selected are outcomes of PPF optimization by the PM: the revealed preference assumption. Reduced form estimation of the PPF by the indirect approach can be accomplished using three methods. The revealed-preference-econometrics method (RPE) utilizes the FOC of the PPF in combination with economic constraints, equation (2), and the revealed preference assumption. The revealed-preference-inverse-control method (RPC) uses information from economic constraints, the revealed preference assumption and an optimal control rule in feedback form (Chow). The revealed-preference-mathematical-programming method (RPM) adapts the PPF problem to standard mathematical programming algorithms.

To understand these methods, consider a second order approximation of the reduced form PPF:

(15) $W_t = s_t' B_t \, s_t + s_t' b_t,$

subject to economic constraints, equation (2). s_t is a vector of $s_{it}(x_t, z_t; g_t)$ for i = 0 to n, b_t is a vector of weights on s_t and B_t is a symmetric weighting matrix. PPF weights are estimated for each time period t.

General Steps

Empirical estimation of a PPF involves the following steps, performed for each period, t = 1 to T.

1) Define the PM and interest groups, i = 1 to n, and their performance measures $s_{it}(x_t, z_t; g_t)$, i = 0 to n.

For example, consider a problem with a PM whose $s_{0t}(x_t, z_t; g_t)$ is treasury costs, and two interest groups: consumers, identified with consumer surplus, $s_{ct}(x_t, z_t; g_t) = CS_t$, and producers, identified with producer surplus, $s_{pt}(x_t, z_t, ; g_t) = PS_t$.

2) Postulate a reduced form PPF. The functional form must be one with FOC linear in the parameters.[3] Each functional form implies a set of parameters, which can be numbered m = 1 to M.

For example, equation (15) is expanded to

(16) $$W_t = B_{00t}\, s_{0t}^2 + 2B_{01t}\, s_{0t}\, s_{ct} + 2B_{02t}\, s_{0t}\, s_{pt} + B_{11t}\, s_{ct}^2 + 2B_{12t}\, s_{ct}\, s_{pt} + B_{22t}\, s_{pt}^2 + b_{0t}\, s_{0t} + b_{1t}\, s_{ct} + b_{2t}\, s_{pt},$$

where rows of B_t in equation (15) are numbered 0 to 2. The number of parameters in equation (16) is M = 9.

3) Select a set of policy instruments x_t, indexed k = 1 to K. There must be at least as many policy instruments K as PPF parameters less one: $K \geq M - 1$. This is necessary, but not sufficient, for PPF parameters to be identified. If the number of policy instruments is less than required, parameters in the PPF must be restricted.

4) Estimate the system of equations (2). Constraints must include policy variables so that impacts of instrument choices x_t are reflected in welfare measures s_t. These relationships may be nonlinear for the RPE or RPM method, but must be linearized when using the RPC method. Each instrument must have an independent effect on change in at least

one performance measure: a necessary and sufficient condition for identification of PPF parameters.

After proceeding through general steps 1 through 4, the problem must be adapted to one of the methods: RPE, RPC, or RPM. Choice of method will depend on the policy problem. RPE and RPM allow single period and multiple period estimation of reduced form parameters, while RPC is most appropriate in a multiple period dynamic framework.

Revealed-Preference-Econometrics Method

This method uses the Jacobian matrix of FOC to generate reduced form PPF parameter estimates. The method outlined here is a generalization of those methods previously utilized in the literature. The next RPE step is:

5) Substitute constraint equations (2) into the PPF through its arguments so the maximization becomes unconstrained. Rewrite each $s_{it}(x_t, z_t; g_t)$ as $s_{it}(x_t, F_t(x_t, z_t; g_t); g_t)$.

6) Maximize the unconstrained PPF with respect to policy instrument set x_t. This may be done analytically, or numerically in cases where substitution of constraints into the PPF is not feasible. A set of first order conditions results. The Jacobian $\tilde{\tilde{J}}_t$ is then formed from the FOC, so that

$$(17) \quad \tilde{\tilde{J}}_t = \left\{ \frac{\partial W_t}{\partial x_{kt}} \right\} = 0,$$

where $\tilde{\tilde{J}}_t$ is a K by M matrix and 0 is a K-component vector.

For example, FOC for equation (16) are

$$(18) \quad \frac{\partial W_t}{\partial x_{kt}} = 2\, B_{00t} \frac{\partial s_{0t}}{\partial x_{kt}} + 2\, B_{01t} \left(s_{ct} \frac{\partial s_{0t}}{\partial x_{kt}} + s_{0t} \frac{\partial s_{ct}}{\partial x_{kt}} \right)$$

$$+ 2\, B_{02t} \left(s_{pt} \frac{\partial s_{0t}}{\partial x_{kt}} + s_{0t} \frac{\partial s_{pt}}{\partial x_{kt}} \right) + 2\, B_{11t}\, s_{ct} \frac{\partial s_{ct}}{\partial x_{kt}}$$

$$+ 2\, B_{12t} \left(s_{ct} \frac{\partial s_{pt}}{\partial x_{kt}} + s_{pt} \frac{\partial s_{ct}}{\partial x_{kt}} \right) + 2\, B_{22t} \frac{\partial s_{pt}}{\partial x_{kt}}$$

$$+ b_{0t} \frac{\partial s_{0t}}{\partial x_{kt}} + b_{1t} \frac{\partial s_{ct}}{\partial x_{kt}} + b_{2t} \frac{\partial s_{pt}}{\partial x_{kt}} = 0,$$

for instruments $k = 1$ to K. If $K = 8$, the Jacobian is an 8 x 9 matrix and the 0 is an 8-component vector.

7) Solve the system of equations (2) using observed values of policy instruments x_t^* and exogenous variables g_t^* to get "observed" endogenous variables z_t^*.

8) Evaluate the Jacobian at (x_t^*, z_t^*, g_t^*). This represents point H in figure 2. Steps 6 and 8 may be more easily performed numerically for some problems.

9) The Jacobian then represents a set of homogeneous equations linear in the parameters, which are rewritten

(19) $\tilde{J}_t \, \tilde{\beta}_t = 0,$

where $\tilde{J}_t$ is the Jacobian $\tilde{\tilde{J}}_t$ with parameters $\tilde{\beta}_t$ factored out. Matrix $\tilde{J}_t$ is K x M, $\tilde{\beta}_t$ is an M-component vector and 0 is a K-component vector. For the example, if $K = 8$, $\tilde{J}_t$ is a 8 x 9 matrix, $\tilde{\beta}_t$ is a 9-component vector, and 0 is an 8-component vector. The parameters $\tilde{\beta}_t = [\ B_{00t},\ B_{01t},\ \ldots\ B_{22t},\ b_{0t},\ b_{1t},\ b_{2t}\ ]$.

10) Select a normalization rule: set the mth parameter to one, $\tilde{\beta}_{mt} = 1$. The remaining parameters are then interpreted as relative to the mth group's parameter. The PPF is only identified to a multiplicative constant. Let β_t represent the normalized set of parameters, an (M-1)-component vector.

For the example, set $\tilde{\beta}_{7t} = b_{0t} = 1$. β_t is an 8-component vector. The PM is then constrained to have a nonzero weight on his performance measure. Because reduced form results may not be invariant to the normalization rule, some experimentation with normalization rules is required.

11) Remove the mth column (j_t) from $\tilde{J}_t$ to leave matrix J_t. The column j_t must correspond to the parameter which was chosen for normalization. Rewrite equation (19) as:

(20) $J_t \, \beta_t = -j_t,$

where J_t is a K x (M-1) matrix, β_t is an (M-1)-component vector, and j_t is a K-component vector.

For the example, J_t is an 8 x 8 matrix, and β_t and j_t are 8-component vectors.

12) In order to estimate the parameters, the J_t matrix must meet the following identification conditions:

(21) necessary $K \geq M - 1$, and

(22) necessary and sufficient rank $(J_t) = M - 1$.

β_t can be estimated by premultiplying equation (20) by J_t' and then by $(J_t'J_t)^{-1}$ to get

(23) $\hat{\beta}_t = (J_t'J_t)^{-1} J_t' (-j_t)$.

If K = M-1, as in the example, then (23) reduces to

(24) $\hat{\beta}_t = J_t^{-1} (-j_t)$.

To ascertain that the PPF has been maximized, the second order conditions must be checked. For the quadratic example, this requires that B_t be negative semidefinite. Resulting weights β_t in equation (23) describe trade-offs among interest groups and the PM inherent in the PPF. The $\hat{\beta}_t$ are point estimates and are valid in a small neighborhood of the optimal point (x_t^*, z_t^*, g_t^*). A total differential of the PPF describes how small changes in policy instruments affect the parameters within the neighborhood. The quality of this information depends on how well the PPF describes the topology of the political-economic game.

If it is assumed that parameters $\tilde{\beta}_t$ remain constant over time, steps 1 - 12 can be utilized to generate a PPF over multiple time periods, t = 1 to T. This has the advantage of greatly increasing the number of estimable parameters (each time period increases the estimable parameter set by the size of the instrument set K and the necessary condition for parameter identification becomes $K\,T \geq M - 1$), but the assumption that policy preference weights remain constant over time may be too restrictive.

PPFs have been estimated in macroeconomics and for agricultural policy using variants of the RPE method. Rausser and Freebairn perform a grid search over sets of parameter values in the PPF and select the parameter set which minimizes the difference between the calculated policy instrument set, conditional on those parameters, and the observed policy instrument set.

Horowitz discusses quadratic loss functions and Friedlaender employs this functional form to analyze U.S. macroeconomic policy. Choice of target values for performance measures $s_{it}(\ )$ is generally made outside the estimation procedure, but this choice largely determines outcomes from PPF optimization, imposing arbitrariness on the function. Choices other than observed variables runs counter to the revealed preference assumption. However, if observed values are chosen, the Jacobian becomes singular in a one-period application.[4] Multi-period application implies the assumption of constancy of parameters over time.

Lianos and Rizopoulos derive a PPF for the Greek cotton industry using an algebraic approach. The number of unknown parameters is restricted to one in a linear PPF, permitting calculation of that parameter directly from the constraints. Unfortunately, most interesting policy problems are more complex and the applicability of this approach is limited.

Most of the work done has followed the general approach taken by Sarris and Freebairn; Love; Nykamp and Somermeyer; Paarlberg and Abbott; and Reithmuller and Roe. A PPF is postulated in economic surpluses and policy variables, a normalization rule is chosen and the FOC are calculated to obtain parameter estimates. Beghin adds restrictions from a game theoretic structure to the model.

Revealed-Preference-Inverse-Control Method

This method is most useful in a multiperiod dynamic framework and becomes trivial when applied to a single period problem. The method is well developed and documented in Chow, and in Fulton and Karp. After completing general steps 1 through 4, estimation proceeds as follows:

5) Linearize any nonlinear relationships in constraints equation (2).

6) Estimate a linear feedback equation for each control (policy instrument) x_{kt}, k = 1 to K.

$$(25) \quad x_{kt} = D_t \begin{bmatrix} z_{t-1} \\ s_{t-1} \end{bmatrix} + d_t,$$

where D_t is a parameter matrix and d_t is a constant.

7) Utilizing equations (25) and (2), along with FOC from a dynamic programming formulation, the PPF parameters can be recovered. Chow documents a two-stage least squares and a full-information maximum likelihood approach (pp. 380-386).

Revealed-Preference-Mathematical-Programming Method

Zusman; and Zusman and Amiad structure the PPF problem in a nonlinear mathematical programming framework. It is not necessary to postulate a PPF because the RPM maximizes the political economic game directly. After completion of general steps 1, 3 and 4, the following steps for this method are well documented (Zusman; Zusman and Amiad; Zusman and Rausser):

5) Solve the political economic game directly to obtain weights in the PPF, as in equations (6) - (11). This is equivalent to

$$(26) \quad \min_{h_{it}} \max_{x_t} \sum_{i=0}^{n} h_{it} \left[s_{it}(x_t, z_t; g_t) - s_{it}(x_t^*, z_t^*; g_t^*) \right],$$

where PPF weights are $b_{it} = h_{it}/h_{0t}$. Operationally, the minimax problem, equation (26), is solved using nonlinear programming.

$$(27) \quad \max_{x_t} V \leq s_{it}(x_t, z_t; g_t) - s_{it}(x_t^*, z_t^*; g_t^*)$$

$$\text{s.t. } F_t(x_t, z_t; g_t) \geq 0,$$

where F_t is the economic constraints as in equation (2). The h_{it} in equation (26) are calculated as

(28) $h_{it} = \lambda_{it} / \sum_{i=0}^{n} \lambda_{it}$,

where λ_{it} is the shadow price of the ith constraint.

Introducing Uncertainty into the PPF

A major criticism of previous work on PPFs is that the stochastic nature of estimated parameters has been swept aside. With the exception Fulton and Karp; and Nykamp and Somermeyer, there is minimal discussion about error structures. Since the unknown parameters are functions of stochastic variables, sampling distributions must accompany point estimates to assess the reliability of estimated parameters and permit hypothesis testing.

The RPE method assumes that matrix $\tilde{J}_t$ is known with certainty; that changes in welfare measures with respect to changes in policy instruments are known and nonstochastic. There are, however, two potential sources of uncertainty in the PPF: stochastic changes in welfare measures with respect to changes in policy instruments and stochastic aspects of the political optimization process. Specifically, consider the FOC of the generalized PPF, equation (5).

(29) $\frac{\partial W_t}{\partial x_t} = \frac{\partial W_t}{\partial s_{it}} \left(\frac{\partial s_{it}}{\partial x_t} + \frac{\partial s_{it}}{\partial z_t} \frac{\partial z_t}{\partial x_t} \right)$.

Uncertainty in the political process implies weights b_{it} are stochastic, and that $\partial W_t/\partial s_{it}$ in equation (29) is stochastic. Uncertainty arising from the transformation of policy instruments and economic variables into performance measures via the constraints, equation (2), implies the terms in parenthesis in equation (29) are stochastic. These two sources of uncertainty are assumed independent, suggesting that errors resulting from stochastic specification of the economic constraints are independent of errors deriving from the political process.

Assuming the uncertainty can be specified as an additive error term, equation (2) can be rewritten as

(30) $z_t = F_t(x_t, z_t; g_t) + v_t$,

where v_t is independently and identically distributed (i.i.d.) $(0, \sigma_v^2)$. Estimation of equation (30) implies the Jacobian is stochastic.

With the introduction of uncertainty into the political policy process, 0 in equation (20) is replaced by random variable e_t:

(31) $\tilde{J}_t \, \tilde{\beta}_t = -e_t,$

where

(32) $E(e_t | \tilde{J}_t) = E(e_t) = 0$ and

$V(e_t | \tilde{J}_t) = V(e_t) = \sigma_{et}^2.$

Equality of the conditional and unconditional means and variances holds because e_t and $\tilde{J}_t$ are assumed independent. Incorporating the stochastic structure, equation (20) can be rewritten as

(33) $-j_t = J_t \, \beta_t + e_t.$

Assuming the errors e_t are i.i.d. across policy instruments x_{kt}, but not necessarily across time, the mean and variance of estimated parameter set $\hat{\beta}_t$ are

(34) $E(\hat{\beta}_t | \tilde{\beta}_m=1) = \beta_t$, and

(35) $V(\hat{\beta}_t | \tilde{\beta}_m=1) = \sigma_{et}^2 \, E[(J_t' J_t)^{-1}],$

where $\tilde{\beta}_m$ is the parameter implicitly set to 1, and β_t is a vector of true coefficients in the PPF. $E[(J_t' J_t)^{-1}]$ is generally unknown. In estimation, J_t is set to the observed values, $J_t = J_t^*$, and equation (35) is interpreted as conditional variance

(36) $V(\hat{\beta}_t | J_t = J_t^*, \tilde{\beta}_m=1) = \sigma_{et}^2 \; (J_t^{*\prime} J_t^*)^{-1}.$

This conditional covariance matrix represents only the political process uncertainty and does not include variance resulting from estimation of constraints, equation (2). Estimation of the unconditional variance, including uncertainty from both sources, would be difficult in a small sample context without restrictive assumptions about the functional forms of the PPF and constraints. Asymptotic properties of PPF parameter estimates may be derived. However, without assuming constancy of parameters across time, large sample properties cannot be obtained.

Since equation (36) does not incorporate the errors in equation (30), it does not provide a good estimate of the variance of $\hat{\beta}_t$. In order to get unconditional variance, $E[(J_t'J)^{-1}]$ must be estimated. Recognizing that $J_t = J_t(v_t)$, application of a resampling technique like the bootstrap over v_t allows estimation of $E[(J_t'J_t)^{-1}]$. However, the variance in equation (36) contains σ_{et}^2, which must also be estimated. Since the PPF weights can be assumed constant only over a short time, the sample size for $\hat{\sigma}_{et}^2$ can be quite small. In the limiting case, the necessary condition for identification, equation (21), holds with equality, and $\hat{\sigma}_{et}^2 = 0$, implying that $V(\hat{\beta}_t)$ is 0. A more appealing approach is to directly estimate the unconditional variance of $\hat{\beta}_t$ using the bootstrap.

Bootstrapping Standard Errors for Parameters in the PPF

The bootstrap is a statistical technique which permits assessment of variability in an estimate by resampling the data at hand (Efron 1979). The method amounts to resampling from the data set and recalculating the statistic some large number of times. The procedure has been shown to be particularly useful in problems where small sample properties of estimators are difficult or impossible to achieve (Efron and Gong; and Efron and Tibshirani), or where large sample results are not possible because only a small data set is available.[5]

Equation (30) can be specified many ways and there is an applicable bootstrap procedure for each specification. The bootstrap can be applied to econometric models where there is simultaneity (Freedman and Peters 1984a; 1984b; and Freedman 1984), heteroscedasticity (Freedman and Peters 1983; Peters and Freedman), correlated errors (Freedman and Peters 1983), autocorrelation (Rayner), dynamics (Freedman and Peters 1983) and nonlinearities (Amemiya p. 135). Freedman and Peters' (1984a; 1984b) application of the bootstrap to three-stage least squares estimation is adapted to estimation of standard errors for PPF parameters.

Construction of standard errors for PPF coefficients using bootstrap methods begins with the economic constraints, equation (2). The economic constraints are estimated over periods t = 1 to T, while PPF parameters are estimated over some subset of T. Equation (2)'s error structure defines uncertainty arising from the economic structural equations which translate policy instrument settings into economic surpluses, as in equation (30). For simplicity, it is assumed equation (30) is a set of q linear simultaneous equations:

(37) $z_t = A\, z_t + B\, g_t + C\, x_t + v_t,$

where A, B, and C are matrices of unknown parameters. A normalization rule is applied so the diagonal elements of A are zero, $A_{ii} = 0$ for all i = 1 to q. v_t is a vector of disturbances at time t. Endogenous variables z_t are simultaneously determined and may be correlated with v_t. Exogenous variables g_t are assumed independent of v_t. Policy variables x_t are taken as given in the bootstrap process. Identifying restrictions assure the invertibility of (I-A). It is assumed that the v_t are i.i.d., that $E(v_t) = 0$ and that $E(v_t v_t') = V$, where V is the covariance matrix.[6] Given these assumptions, the coefficients in equation (37) can be efficiently estimated using three-stage least squares (Zellner and Theil) to obtain $\hat{A}$, $\hat{B}$ and $\hat{C}$.

To estimate unconditional standard errors for PPF parameters, the bootstrap is performed as follows:

1) Fix the parameters in equation (37) at their estimated values and compute the residuals:

(38) $\hat{v}_t = z_t - \hat{A}\, z_t - \hat{B}\, g_t - \hat{C}\, x_t,$

2) Assume the true errors follow the empirical distribution of the residuals. Generate data sets from the underlying model by randomly drawing calculated residual vectors with replacement T times. Each draw selects a q-vector of errors, $\hat{v}_t^* = (\hat{v}_{1t}^*, \hat{v}_{2t}^*, \ldots, \hat{v}_{qt}^*)$, where the $\hat{v}_t^*$s each have probability 1/T of being drawn.[7]

3) A large number r = 1 to R of "pseudodata" sets, denoted by "*," are generated for period t = 1 to T:

(39) $z_t^* = (\hat{B}\, g_t + \hat{C}\, x_t + \hat{v}_t^*)\ (I - \hat{A})^{-1}.$

Freedman and Peters (1984a) use R = 400.

4) Estimate unknown matrices of coefficients in (37) for each set of pseudodata to obtain estimates of $\hat{A}_r^*$, $\hat{B}_r^*$ and $\hat{C}_r^*$ for each r = 1 to R.

5) Form the Jacobian $\tilde{\tilde{J}}_{rt}^*$ for each pseudodata set and generate a corresponding estimate of the PPF parameters, $\hat{\beta}_r$, using steps 5 through 12 of the RPE method.

6) The mean of R sets of parameters can be calculated as:

(40) $$\sum_{r=1}^{R} \hat{\beta}_r^* \,/\, R = \bar{\hat{\beta}} \approx E(\hat{\beta}),$$

and the variance as:

(41) $$\sum_{r=1}^{R} (\hat{\beta}_r^* - \bar{\hat{\beta}})^2 \,/\, (R - 1) \approx \text{diag}\ (V(\hat{\beta})).$$

Mean and variance of PPF parameters resulting from the bootstrap are conditional only on the parameter normalization rule.

Resampling techniques like the bootstrap can also be applied to the RPC and RPM. Fulton and Karp discuss large sample properties obtainable using RPC. A comparison of alternative estimation techniques is presented in Table 1.

Hypothesis Testing

Having obtained standard errors of estimated PPF weights, a number of hypothesis tests can be performed. It is important to test for stability of PPF parameters across time:

(42) $H_0\!: \tilde{\beta}_t = \tilde{\beta}_{t-1}$

$H_A\!: \tilde{\beta}_t \neq \tilde{\beta}_{t-1}.$

Variations of this hypothesis test include testing a subset of parameters for stability or extending the test over multiple time periods. While many empirical studies have assumed constant parameters over the period of estimation, this test has yet to be performed.

Hypothesis tests to identify underlying gaming structure of PPF reduced form estimates can be constructed in some cases. Each political-economic game solution implies a PPF specification, though many games may result in observationally equivalent PPFs. Hypothesis tests can be constructed to reject all game solutions inconsistent with the estimated PPF. For example, consider the utilitarian game above, which implies that all weights equal 1. If a quadratic PPF is estimated, as in equation (15), and standard errors are generated using the bootstrap, a hypothesis test for utilitarian structure is:

(43) H_0: $\tilde{\beta}_t = [\ 0,0,0,0,0,0,0,0,0,1,1\ ]'$

H_A: $\tilde{\beta}_t \neq [\ 0,0,0,0,0,0,0,0,0,1,1\ ]'$.

Under the null, no element of B can be significantly different from 0 and the linear terms b_{it} must not statistically differ from 1. If H_0 is rejected, the utilitarian game can be rejected as a description of political-economic agents' behavior.

Political-economic behavior as modeled by Becker and by Peltzman requires that the parameter on the PM's performance measure be zero because the PM exerts no differentiable influence on policy. Tests of their models can be constructed by normalizing on an interest group other than the PM. Hypothesis tests can also be constructed to test for relative strength of interest groups.

If political-economic variables p_{it} and c_{it} were observable, hypothesis tests could be constructed to directly test for game specification. In the absence of such data, Zusman; Zusman and Amiad; and Beghin have proposed techniques for parameterization of these unknown variables. These techniques, in combination with the bootstrap, may permit specific hypothesis tests for game structure.

Model Validation

To be useful in policy evaluation, the PPF must be validated. Confidence intervals around PPF parameters provide an immediate indication of model validity. If intervals are wide, the estimated PPF contains little information and will not be useful for policy applications. Consider two other types of validity tests: those which assess predictive ability and those which compare results from alternative techniques for estimating PPF parameters.

Predictive ability of a PPF can be assessed by comparing predicted policy outcomes with observed policy instruments. The estimated PPF is maximized subject to economic constraints with exogenous variables set to observed levels g_t^* to derive predicted policy outcomes $\tilde{x}_t$. Predicted policy outcomes are then compared to the observed policy instrument set x_t^*. The closeness of the estimated set of policy instruments to the observed set can be assessed for each time period using mean squared error or an alternative statistic. In cases involving multiple periods, mean squared error can be calculated for the entire time frame.

A second evaluation criterion is comparison of the instrument set $\tilde{x}_t$ predicted from PPF maximization with predictions from a control rule in which instruments are functions of exogenous variables g_t alone. This assessment of predictive ability determines whether the structured PPF prediction is closer to observed policy than projections based on a simple data-intensive specification.

A third PPF validation technique is the sample impact multiplier test (Beghin). This test is based on comparison of coefficients from reduced form estimates of policy instruments on exogenous variables with impact multipliers obtained from simulations of the structural policy preference model. Impact multipliers are obtained numerically by optimizing the estimated PPF subject to economic constraints, as in the predictive ability test above. Exogenous variables are in turn set at two different values within a small neighborhood of the observed values to calculate impact multipliers for the effects of changes in exogenous variables on optimal policy settings. The impact multipliers are then compared with corresponding coefficients from data-intensive reduced form estimates of observed policy instrument settings on exogenous variables. Impact multipliers from PPF simulations should be similar in sign and magnitude to reduced form parameter estimates.

A direct validation test of PPF parameters utilizes the performance measure transformation frontier (Gardner 1983). Evaluating the total differential of the PMTF at observed policy instruments x_t^* yields the slope of the separating hyperplane between the PMTF and the iso-policy preference curve at optimal point H (figure 2). The marginal rate of transformation among performance measures on the PMTF and the marginal rate of substitution among performance measures in the PPF must be equal at the point of tangency. The PPF FOC evaluated at the predicted policy instrument set $\tilde{x}_t$ and the total differential of the PMTF evaluated at the observed instrument set x_t^* should be equal within a statistical confidence interval.

Uses of the PPF in Policy Formulation

Traditionally, policy evaluation has been performed in an economic efficiency framework. Such assessments are misleading since political dynamics of policy formulation are ignored. For example, the Kaldor-Hicks criterion considers only economic efficiency: if winners can compensate losers, a policy action should be taken. Political reality may mandate that such compensation take place for the policy to be implemented (Rausser and Foster). An example of this is the Conservation Reserve Program (CRP), under which farmers are paid to retire land from farming to conservation uses. Without payments for retired land, the program is not politically feasible. Indeed, presence of social gains may provoke new rent-seeking activities which absorb any potential policy benefits. For instance, farmers in the CRP have an incentive to lobby for payment levels which capture all of the social gains from land conservation. Hence, policy analysis considering only economic efficiency is incomplete. To ensure a political-economic equilibrium, analysis must be performed in a political-economic framework, as offered by the PPF.

A validated PPF can be used to evaluate alternative policy scenarios over a short planning horizon during which the weights can be assumed constant. Variable W_t then becomes an ordinal measure of policy desirability. Differences in absolute policy preference levels cannot be readily interpreted.

Iso-policy preference curves (IPPCs) for the estimated PPF can be constructed by varying the values of performance measures. Such analyses trace out sets of performance measures over which the political economy is indifferent. IPPCs can be used to investigate ways of moving from one policy regime to another without affecting political-economic well-being. IPPC analysis can assist the PM in managing change. For instance, success of proposed changes in the General Agreement on Tariffs and Trade (GATT) would decrease subsidies to agriculture and move this sector toward a free market. Any compensation which must be paid to losers to make them indifferent between policy regimes can be determined from PPF analysis, in contrast to "full" compensation computations.

Just and Rausser; and Just propose use of PPFs to generate flexible policy rules to ease transition caused by economic shocks. The advantage of these rules, demonstrated by Love, is that they allow policy instrument settings to vary with economic changes, e.g. market signals, in a manner that is consistent with policy preferences of political-economic agents.

New Directions

Policy preference functions are important instruments for policy analysis. When properly estimated and validated, PPFs provide vehicles for testing hypotheses about political-economic structure and for assessing alternative policy regimes. Refinement of estimation and validation techniques will make the PPF a more useful policy evaluation tool.

PPF analysis is currently limited in applicability since estimated parameters are valid only within a neighborhood of observed policy settings. Consideration of a wider range of policy settings requires understanding of how policy settings change PPF weights. Identification of underlying game structure would allow PPF weights to vary with changes in political and economic environments. Two forms of endogeneity of the weights are possible: within-game endogeneity and across-game endogeneity. The former limits players to a particular game structure. Across-game endogeneity allows the game to change endogenously. Better knowledge of political-economic behavior would permit global policy analysis and lead to a new understanding of the realities of policy formation.

Footnotes

1. This derivation generally follows Zusman; and Rausser (1990). Following Nash, Zusman models the policy process as a noncooperative game in which disagreement payoffs are determined followed by a cooperative game which maximizes joint payoff. However, Western-style democratic policy processes are cooperative games in which participants compromise on a policy without inflicting penalties. The judicial system in western democracies ensures that such cooperation takes place. Therefore, only a cooperative game is considered.

2. The initial levels of the performance measures replace the Nash-Harsanyi disagreement payoffs described by Zusman.

3. This technique can be extended to specifications with FOC nonlinear in the parameters. However, the computational costs are very high.

4. Consider

$$\text{(F1)} \quad \min_{x_{it}} W_t = (s_{it} - \tilde{s}_{it})' A_t (s_{it} - \tilde{s}_{it})$$

$$= \min_{x_t} [s_{it}'A_t s_{it} - 2 \tilde{s}_{it}'A s_{it} + \tilde{s}_{it}'A_t\tilde{s}_{it}]$$

where the $\tilde{s}_{it}$ represents the target levels of the welfare measures and A_t is a weighting matrix. The FOC are

$$\text{(F2)} \quad \frac{\partial W_t}{\partial x_{it}} = 2 \frac{\partial s_{it}}{\partial x_{it}} A_t s_{it} - 2 A_t\tilde{s}_{it} \frac{\partial s_{it}}{\partial x_{it}} = 0.$$

When the observed values of the targets, $\tilde{s}_{it}$, are substituted into the FOC, they can be rewritten

$$\text{(F2)} \quad \frac{\partial W_{it}}{\partial x_{it}} = 2 (A_t - A_t) \tilde{s}_{it} \frac{\partial s_{it}}{\partial x_{it}} = 0$$

5. A number of studies have demonstrated the superior quality of estimates of sampling variance produced by the bootstrap method when compared to asymptotic results based on Taylor series. In particular, when the errors are 1) independently and identically distributed, 2) approach the standard normal distribution when sample size gets large, and 3) have a valid expansion, the bootstrap achieves convergence faster

than the normal distribution approximation (Singh; Abramovitch and Singh; Hall; Efron 1979, 1987; and Beran 1982, 1987, 1988). The bootstrap is distribution-free and develops the approximate finite sample behavior for the estimates.

6. In cases where errors are not i.i.d., a feasible Aitken's estimator for the appropriate error structure is more efficient. When political errors are not independent of errors in the economic model, an instrumental variables estimator can be formulated using the projection of endogenous variables on exogenous variables ($\hat{z}_{qt} = g_t'\hat{\alpha}_q$, where $\hat{\alpha}_q$ is the OLS estimator of z_q on g for each endogenous variable z_q) together with exogenous variables g_t to evaluate the derivatives in J_t to form instruments $\hat{J}_t$. The instrumental variable estimator is then $\hat{\beta}_t = (\hat{J}_t'J_t)^{-1}\hat{J}_t'(-j_t)$.

7. Some inflation of the $\hat{v}_t$* may be desirable because of deflation of errors which occurs in estimation. However, there is no generally accepted inflation rule (Freedman and Peters 1984a; 1984b).

Table 1.

Comparison of Alternative Estimation Techniques.

	RPE	RPC	RPM
Restrictions on Functional Forms	PPF linear in FOC	Quadratic PPF Linear Constraints	None
Informational Restrictions	None	None	Knowledge of game objective
Estimation Period	Single or Multiple	Multiple only	Single or Multiple
Static/Dynamic	Either	Dynamic	Either
Computational Requirements	Slight for single period estimation	Moderate	Depends on functional forms
Standard Errors	Resampling required	Asymptotic results, may be resampled	Resampling required
Game Requirement	Game General	Game General	Game Specific

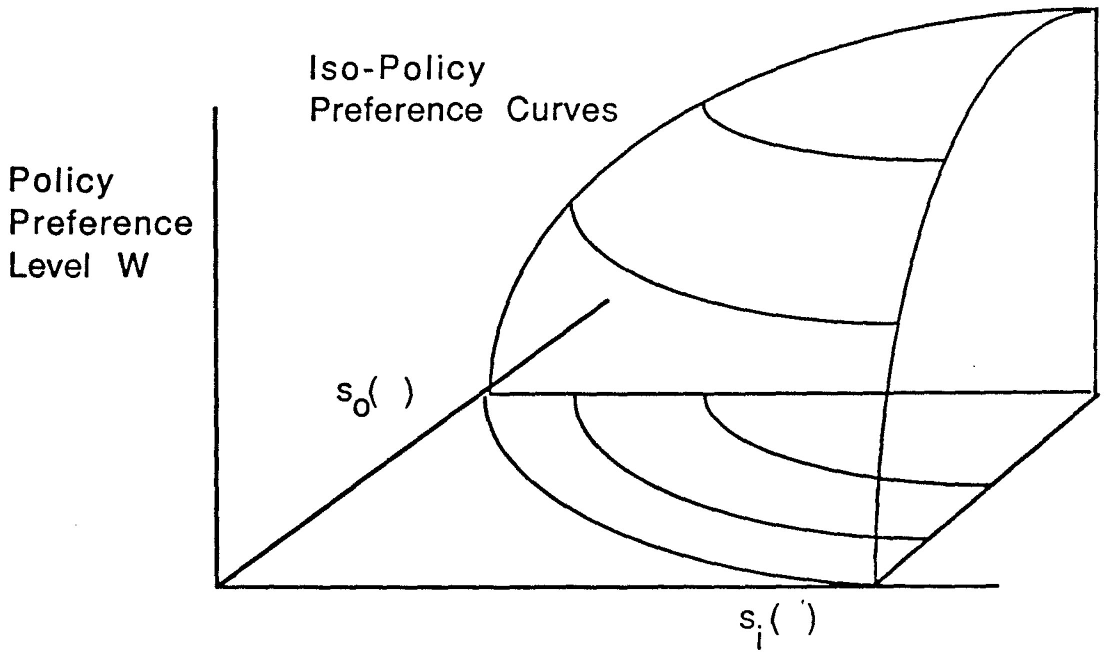

Figure 1. Policy Preference Surface

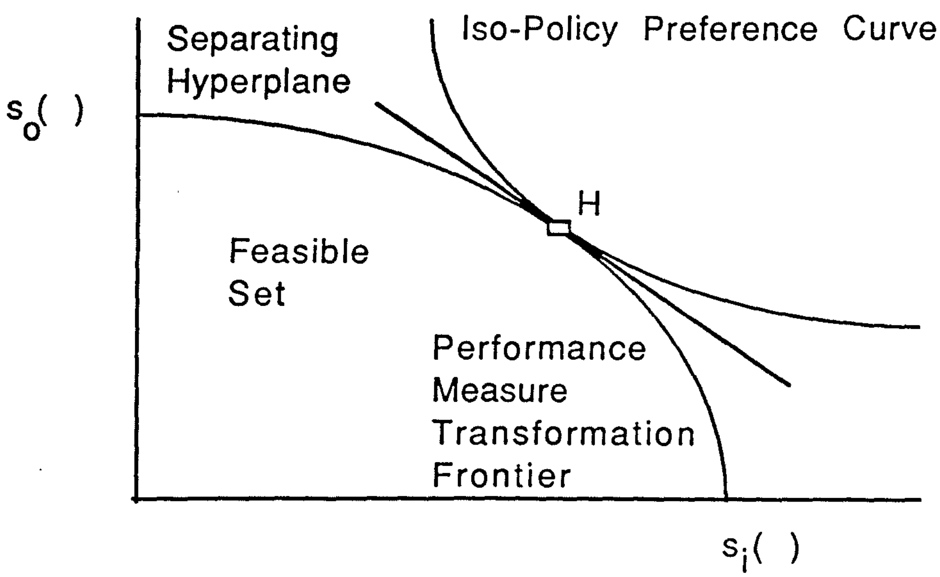

Figure 2. Performance Measure Transformation Frontier and Iso-Policy Preference Curve

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