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BARGAINING OVER AGRICULTURAL-ENVIRONMENTAL POLICY

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Bargaining Over Agricultural-Environmental Policy

One lesson learnt from the Food Security Act (FSA) of 1985 debate was that agricultural policy is too important to be left to farmers and farm interests (Reichelderfer and Hinkle). For a long time the exclusive domain of agricultural interests, agricultural policy debates in the 1980s have integrated many nonagricultural interests ranging from foreign policy groups to domestic environmental interest groups. Prior to 1970, the environmental consequences of agricultural policy provisions were of tangential, if any, concern to agricultural policy makers. This is not to say that agricultural policy always ignored environmental concerns: there are well documented cases to the contrary. But in most instances the primary target of the policy was benefiting an agricultural (and not environmental) interest. The Soil Bank of the 1950s is a case in point. Although the creation of the Soil Bank had obvious environmental implications its primary purpose was to eliminate excess agricultural production. Of secondary concern was the desire to preserve productive land for future generations (Cochrane and Ryan).

Even though environmental interests are important actors in the agricultural policy debate, relatively little is known in a formal sense about how farm and environmental interests are melded into a single policy implement like the FSA of 1985. This paper represents a preliminary attempt to examine these interactions formally. The discussion focuses primarily on the Conservation Acreage Reserve Program (CARP) contained in Title XII of the FSA of 1985. A striking aspect of the CARP was the broad support it drew from both farm and environmental groups (Phipps). Such support is in stark contrast to traditional farm-environmental relations and the ongoing debate over chemical usage in commercial agriculture.

Why environmental groups favored the CARP is clear: it was meant to take environmentally fragile agricultural lands out of production. Understanding why farm groups supported the CARP is less clear but several explanations have emerged (Phipps). A traditionalist explanation is that farmers saw in the CARP another Soil-Bank program that would curb excess production. Before accepting this explanation, however, one should be careful. For in 1985, a point of unanimous policy agreement was that U.S. agriculture had to recapture lost international markets by expanding exports. And it was well recognized that one consequence of the 1983-1984 Payment In Kind (PIK) program was that the United States lost world market share as foreign suppliers replaced U.S. suppliers in markets vacated as a result of PIK. Another explanation for farm support of CARP was that farmers saw CARP as an income-transfer program. Ex post, a problem with this explanation has emerged as well: Hyberg, Dicks, and Hebert recently reported that CARP rental payments to farmers are not large enough to offset income foregone as a result of acreage retirement.

If farmers really suffered income losses from the CARP, is the only conclusion that farmers simply made a bad policy deal? While certainly possible, relying on a "mistake" theory of policy is not very scientific. And although such a theory offers a ready explanation for every policy conundrum it also offers little in the way of prediction. Fortunately, another stylized fact from the 1980s may explain why farmers found the CARP so attractive: between 1980 and 1985 agricultural asset values declined from roughly $1 trillion to approximately $600 billion. Farmers suffered a staggering wealth loss in a very short period. Following such a wealth loss, a program promising risk-averse farmers a chance to trade part of a risky lottery with nature and world markets (farming) for a guaranteed stable income (even if lower than expected farming income) over a 10-year period must have been attractive.

This paper does not try to resolve the true reasons farmers chose to go along with the CARP. A final answer is well beyond the scope of any single paper. Rather we focus on this last observation and investigate the generic problem it raises: how agricultural-environmental policy choices are affected by a sudden erosion of the wealth position of one party to the agricultural policy process. Doing so requires a model of the agricultural policy process as well as the farmer-environmentalist policy problem. This model is built around the rudiments of the CARP for the sake of concreteness and intuition.

The agricultural-environmental policy process is viewed as a Nash bargaining game between farmers and environmental interests. The Nash bargaining game is structured so that risk-averse farmers and environmentalists are trying to agree on how much environmentally fragile agricultural land should be retired from agricultural production and on what payment farmers should receive for retiring this land.

The Model

Farmers and Environmentalists

Agricultural-environmental policy is here presumed to result from the interaction of two groups -- farmers and environmentalists. The assumption that agricultural-environmental policy results from the interaction of only two groups is, of course, heroic. It is intended as a first approximation capturing the essential elements of the many competing interests involved in formulating agricultural policies which impinge heavily upon the environment.

Farm interests are only concerned with returns from farming while environmental interests are only concerned with preserving some currently used environmentally fragile agricultural land. This is strong: environmental interests also presumably have interests as consumers of agricultural products and farm groups undoubtedly have a self interest in preserving agricultural land. These interests, ignored here, undoubtedly would lead environmentalists and farmers to act in a somewhat different fashion than this paper purports. The strong dichotomy of interests is maintained to preserve clarity and simplicity in representing the often conflicting goals of environmental interest groups and farm lobbies.

Both farmers and environmentalists are assumed aggregable in the sense that there exists a single criterion function representing aggregate farm interests and a single criterion function for aggregate environmental interests. This assumption, too, is strong. Its main justification again is simplicity, but it is not completely unrealistic. Vast groups of farmers are frequently represented in the legislative and policy making process by commodity and/or general farm organizations with active lobbying arms (American Farm Bureau; National Association of Wheat Growers; American Soybean Association, etc.). The same is true for environmentally concerned citizens. The reality is that these organizations and their lobbyists "make" agricultural-environmental policy (along, of course, with the politicians). Farmers and individual citizens do not.

Aggregate farm interests are represented by a cardinal, von Neumann-Morgenstern utility function $v\colon \mathbb{R} \to \mathbb{R}$. v is at least thrice differentiable, strictly increasing, and strictly concave. Total returns from farming are stochastic and denoted by R. Let $G(R,a)$ be the conditional distribution function for R when total environmentally-fragile acreage farmed is a. The stochastic returns specification is general enough to allow for both production and price uncertainty. Assume that a has positive marginal returns in the following sense: if $a^0 \geq a$, then $G(R,a^0) \leq G(R,a)$ with a strict inequality for some R (first-order stochastic dominance).[1] G(R,a) is differentiable and strictly increasing for all possible R. Let g(R,a) denote $G_R(R,a)$. If $a \leq a^0$ farmers attach less risk to G(R,a) than $G(R,a^0)$ in the sense that

$$\int_{R*} v(R + \bar{R}(a^0) - \bar{R}(a))\, dG(R,a) \geq \int_{R*} v(R)\, dG(R,a^0)$$

where $\bar{R}(k) = \int_{R*} R\, dG(R,k)$. Denoting initial farm wealth as W yields the following expression for aggregate farm expected utility

$$V(a,W) = \int_{R*} v(R + W)\, dG(R,a).$$

when aggregate acreage is set at a. Here $R^* \subseteq \mathbb{R}$ is the bounded support of G(R,a).

V(a,W) is assumed strictly increasing and strictly concave in both its arguments. That V is strictly increasing and concave in W follows from the assumptions already made upon v. V is also strictly increasing in a by first-order stochastic dominance. Concavity in a, however, implies

$$\int_{R*} v(R + W)\, dG_{aa}(R,a) \leq 0.$$

Integrating this last expression by parts gives

$$-\int_{R*} v'(R + W)\, G_{aa}(R,a)\, dR \leq 0.$$

This last expression holds if G(R,a) is convex in a. Convexity of G(R,a) implies for $0 \leq \lambda \leq 1$

$$G(R, \lambda a + (1 - \lambda)a') \leq \lambda\, G(R,a) + (1 - \lambda)\, G(R,a').$$

In other words farm interests always have available to them an a that first-order stochastically dominates what they can achieve by randomizing strategies between any two acreage levels.[2]

Aggregate environmental interests are characterized by a von Neumann-Morgenstern utility function linear in wealth, i.e., they are risk-neutral. Aggregate environmental willingness to pay for having land preserved is described by the strictly increasing and strictly concave function $u\colon \mathbb{R}_+ \to \mathbb{R}$. Letting ℓ denote the amount of fragile land preserved, W the initial wealth of environmentalists, and b the amount environmentalists pay to have ℓ retired gives the following measure of environmentalist welfare

$$u(\ell) + W - b.$$

Without loss of generality, we normalize environmentalists' preferences so that $u(0) = 0$.

Policy Formation

To motivate the interplay between farm and environmental interests consider the following contrived *noncooperative policy game*: Farmers have title to all the environmentally fragile agricultural land which is assumed fixed in quantity and denoted by L. Their title gives them the exclusive right to determine how the land is utilized. Environmental interests are affected by what farmers do with L because ℓ is determined by the identity $\ell = L - a$. But because environmentalists lack ownership rights, they cannot directly affect the size of ℓ. Environmentalists could, however, offer to pay farmers a fixed amount b to retire ℓ units of land from production. So long as $u(\ell) - b > 0$, environmental interests would be better off doing so. Now suppose farmers and environmentalists must determine independently (noncooperatively) ℓ and b, respectively. The Nash equilibrium for this simple game is $b = 0$, $\ell = 0$.[3] Farmers taking b as given maximize their expected utility by not retiring any land. Similarly environmentalists taking ℓ as given maximize their well being by setting $b = 0$. The Nash equilibrium, illustrated graphically as the origin in Figure 1, represents the pre-CARP situation. The assumptions on u and V insure that the farmer indifference curve passing through the Nash equilibrium is positively sloped and convex while that for environmental interests is positively sloped and concave.

The shaded area in Figure 1 represents the possible Pareto-superior trades that could be reached by cooperation or direct bargaining between farmers and environmentalists. (Note environmentalists can never offer a larger b than their preexisting wealth and farmers can never retire more than L units of land.) If farmers and environmentalists were rational, therefore, they would recognize that they each could do better than this simple noncooperative game by cooperating, i.e., they can move into the shaded region in Figure 1. The *bargaining problem* or *cooperative policy game* then is to determine where in the shaded area farmers and environmentalists might end as a result of policy bargaining. Finding the solution to this bargaining problem and how that solution is affected by a change in farmer's initial wealth is the focus of the rest of the paper.

So far nothing has been said about the role that politicians play in the policy process. To say that agricultural-environmental policy results only from bargaining between farmers and environmentalists means that politicians must be playing a "neutral" role or that they can be included in either the aggregate farm interest group (the old Farm Bloc is a case in point) or the aggregate environmental group. We explicitly assume that any politicians not included in the interest groups play the role of "honest brokers": they determine the solution to the bargaining problem and enact legislation legalizing the outcome.

The Intuitive Solution

If both farmers and environmentalists are rational and know each other's preference structures, it is reasonable to restrict consideration of cooperative solutions to Pareto-optimal solutions on the contract curve (denoted by the locus EF in Figure 2). Just where on the contract curve the cooperative solution emerges is determined by the solution concept used. The (symmetric) Nash solution used here maximizes the geometric average of the farmers' and environmentalists' gains realized by diverging from the Nash equilibrium.[4]

Let the Nash solution be (b^*, ℓ^*). As illustrated both farmers and environmentalists are strictly better off as a result of cooperation. Farmers retire a strictly positive amount of acreage in return for a strictly positive payment from environmentalists. Because farmers are risk-averse, however, the payment b^* can be smaller than the expected-returns loss, $\int_{R_*} R[g(R,L) - g(R,L - \ell^*)]dR$ (also see below), which farmers suffer as a result of retiring ℓ^* from production. Environmentalists on the other hand prefer the bargaining solution because their willingness to pay for retiring ℓ^* exceeds b^*.

The problem we have set ourselves is to determine what happens to this policy bargain when farmers suffer a wealth loss. Rough intuition would suggest that the farmers bargaining position deteriorates so environmentalists can expect to strike a better bargain. To see why this is plausible consider: if risk aversion is decreasing in wealth farmers are more risk-averse after a sudden wealth loss than before. Presumably, therefore, the farmers' risk premium rises suggesting that farmers are willing to accept less than b^* to retire ℓ^*. Environmentalists, therefore, gain.

This intuition is exactly correct if the farmers' wealth loss shifts the farmers' indifference curve through the Nash equilibrium in a manner consistent with that illustrated in Figure 2. There the point of intersection between the environmentalists' and farmers' indifference curves through the Nash equilibrium remains unchanged, and the result of the wealth loss by farmers is to expand <u>in all directions</u> the set of Pareto-superior policy bargains. (Roth demonstrated a similar result for the case where increased risk aversion is associated with a monotonic concave transformation of one bargainers utility function.) Intuitively, the farmers' wealth loss just expands the feasible set of policy bargains. Because the original policy bargain remains available, however, environmentalists never would agree to switch from it as a result of the wealth loss by farmers unless doing so implied an improvement in their welfare.

Generally, however, one cannot expect this condition to be satisfied. A wealth loss by farmers not only changes the set of feasible policy bargains -- it also changes the farmers' expected utility that is achieved in the Nash equilibrium. Originally this expected utility is $V(L,W)$, after a wealth loss of Δ, it is $V(L,W - \Delta)$. Thus while the Nash equilibrium remains the same, the consequences of being there change for farmers. All potential policy bargains must now be compared to $V(L,W - \Delta)$ not $V(L,W)$. As a result, the set of acceptable bargains can easily shift in a fashion quite distinct from that discussed above. One possibility, illustrated in Figure 3, is that (b^*, ℓ^*) may no longer be acceptable to farmers. Fortunately, outcomes like those illustrated in Figure 3 can be ruled out if a wealth erosion leaves farmers more risk averse (in a sense to be made precise below), and as a result we can expect environmentalists to strike a better bargain for themselves in the policy process.

The Formal Analysis

The solution concept to the cooperative policy game is Nash's solution. The Nash equilibrium is taken as the disagreement outcome. Roth shows that if the Nash bargaining game satisfies the following four axioms: independence of equivalent utility representations (automatically met by our assumption that both farmers and environmentalists have cardinal, von Neumann- Morgenstern preferences), symmetry, independence of irrelevant alternatives, and strong individual rationality the solution to the policy bargaining game is either the Nash solution or the disagreement solution (the Nash equilibrium). Moreover, the Nash solution is strongly Pareto optimal.[5]

The set of (b, ℓ) pairs which leave both environmentalists and farmers at least as well off as the Nash equilibrium is denoted $\mathcal{F}(W)$. Formally,

$$\mathcal{F}(W) = \{(b,\ell) : u(\ell) - b \geq 0,\ V(L-\ell,\ W + b) \geq V(L,\ W),\ 0 \leq b \leq W,\ 0 \leq \ell \leq L\}.$$

$\mathcal{F}(W)$, which is assumed nonempty, is both compact and convex. Nash's solution solves

$$\text{(1)} \qquad \underset{(b,\ell) \in \mathcal{F}(W)}{\text{Max}} \{ (V(L - \ell,\ W + b) - V(L,W))(u(\ell) - b)\}.$$

A well-defined solution exists to (1) by the Weierstrass theorem. Because the Nash solution is always Pareto-optimal (Roth), it is convenient to solve (1) sequentially. The Nash solution is also given by:

$$\text{(2)} \qquad \underset{U \in \mathbb{R}_+}{\text{Max}} \{ (V^*(U,W) - V(L,\ W))\ U\}$$

where $V^*(U,W)$ is the Pareto-optimal expected utility frontier defined by

(3) $$V^*(U, W) = \underset{b,\ell}{\text{Max}} \{ V(L - \ell, W + b) : (b,\ell) \in \mathcal{F}(W), u(\ell) - b \geq U\}.$$

A Lemma on Decreasing Absolute Risk Aversion

The farmer's acceptance set for the Nash equilibrium is the set of (b,ℓ) policy bargains which leave the farmers at least indifferent to the Nash equilibrium.

$$A_F(W) = \{ (b,\ell): V(L - \ell, W + b) \geq V(L,W), b \in \mathbb{R}_+, 0 \leq \ell \leq L\}.$$

$\mathcal{F}(W) \subseteq A_F(W)$. An obvious property of the elements of $\mathcal{F}(W)$ is that no feasible alternative facing the farmer is completely risk free. Rather, farmers face a set of alternative lotteries (indexed by ℓ) with nature and the market. Under such circumstances, Ross shows that the Arrow-Pratt measures of risk aversion are not strong enough (because they always compare a risk-free alternative and risky alternative instead of two risky alternatives) to yield even some apparently sensible results: for example, an individual A can be more risk-averse in the Arrow-Pratt sense than B and still be only willing to pay a lower insurance premium than B.

The Ross insurance premium relative to the Nash equilibrium, $\pi(\ell,W)$, is defined by the implicit equation

$$V(L - \ell, W + \bar{R}(L) - \bar{R}(L - \ell) - \pi(\ell,W)) = V(L,W).$$

The farmer's utility function exhibits (local) decreasing absolute risk aversion (in Ross's strong sense) if $\pi(\ell,W)$ is decreasing in W. But notice that by the monotonicity of V(L,W) that

$$\bar{R}(L) - \bar{R}(L - \ell) - \pi(\ell,W) = b(\ell,W)$$

where

$$b(\ell,W) = \text{Min} \{ b : (b,\ell) \in A_F(W) \}.$$

In words, $b(\ell,W)$ is the minimum payment farmers will accept to retire ℓ units of land from production. In Figure 1, for example, $b(\ell,W)$ for $\ell = \ell'$ is given by b'. $b(\ell,W)$ is smaller than the expected revenue loss associated with retiring ℓ by the insurance premium $\pi(\ell,W)$. So for the farmer's utility function to exhibit decreasing absolute risk aversion $b(\ell,W)$ must be increasing in W. Graphically, this means $A_F(W)$ and $\mathcal{F}(W)$ expand (contracts) locally for fixed ℓ as W decreases (increases).

Substituting for $\pi(\ell,W)$ in the implicit function and differentiating reveals

$$\partial b(\ell,W)/\partial W = [V_2(L,W) - V_2(L-\ell,\ W+b(\ell,W))]/\ V_2(L-\ell,\ W+b(\ell,W)).$$

We, therefore, have the following lemma:

Lemma: Farmers' preferences exhibit decreasing absolute risk aversion (in W) at $\hat{\ell}$ if and only if $V_2(L,W) - V_2(L-\hat{\ell},\ W+b(\hat{\ell},W)) \geq 0$.

Pareto-Optimal Choices

First-order conditions for (3) are

$$-V_1(L-\ell,\ W+b) + \lambda u'(\ell) = 0 \tag{4}$$

$$V_2(L-\ell,\ W+b) - \lambda = 0$$

$$u(\ell) - b - U = 0$$

where λ is a nonnegative Lagrangian multiplier. Letting $\ell(U,W)$ and $b(U,W)$ denote the solution to (4), differentiating (4) totally, and solving provides the following comparative static results for any Pareto-optimal outcome:

$$\frac{\partial \ell(U,W)}{\partial W} = \frac{u'V_{22} - V_{12}}{\Delta} \tag{5}$$

$$\frac{\partial b(U,W)}{\partial W} = \frac{(u')^2 V_{22} - u'V_{12}}{\Delta}$$

$$\frac{\partial \lambda}{\partial W} = \frac{V_{12}^2 - V_{22}(V_{11} + \lambda u'')}{\Delta}$$

$$\frac{\partial \ell(U,W)}{\partial u} = \frac{V_{12} - u' V_{22}}{\Delta}$$

$$\frac{\partial b(U,W)}{\partial U} = \frac{V_{12}^2 - V_{22}(V_{11} + \lambda u'')}{\Delta}$$

where

$$\Delta = 2u' V_{12} - (u')^2 V_{22} - (V_{11} + \lambda u').$$

Second-order conditions for (3) require Δ to be negative.

Several interesting results emerge from (5): the marginal effect on $\ell(U,W)$ of a change in W is minus the the marginal effect on $\ell(U,W)$ of a change in U. In general, one expects both of these effects to be ambiguous. To see why consider Figure 4 where the original Pareto-optimal solution is given by (b^p, ℓ^p). Now let U rise to U′ as illustrated. The new Pareto-optimal solution is at (b^n, ℓ^n) with $\ell^n > \ell^p$. But now consider Figure 5 which represents a similar comparative static effect on the Pareto-optimal solution for slightly different preferences than those in Figure 4. The effect of an increase in U on ℓ is negative there: less land is retired as the utility of environmentalists increases. In what follows, we refer to the case where $\ell(U, W)$ is increasing in U (and therefore decreasing in W) as *normal*. The intuition here roughly parallels that derived from usual consumer theory.[6] Ostensibly one expects raising the environmentalist's well being is associated with an increase in ℓ even though it can be associated with a fall in b and a fall in ℓ.

Turning to b(U,W) it follows from (5) that when $\ell(U,W)$ is normal b(U,W) is decreasing in W. In other words, a wealth erosion leads farmers to farm less land but demand an increased payment not to farm in the normal case. However, inspecting the expression for $\partial b/\partial U$ reveals that its numerator is negative by the second-order conditions for (3). (This expression is minus the second principal minor of the Hessian of (3)'s Lagrangian.) Hence, the Pareto-optimal payment to farmers is always increasing as U increases.

The optimal Lagrange multiplier is also increasing in wealth as the numerator of that expression is also negative as a result of the concavity of V and U().

The Nash Solution

Let the solution to (1) be denoted as $(b(W), \ell(W))$. By (2) and (3) it follows that

$$(6) \qquad b(W) = b(U(W), W), \text{ and}$$
$$\ell(W) = \ell(U(W), W),$$

where U(W) is the solution to (2). The first-order conditions for (2) require

$$(7) \qquad V^{*}(U,W) - V(L,W) + V_{1}^{*}(U,W) \times U = 0.$$

Differentiating (7) with respect to W and solving gives

$$(8) \qquad \frac{dU(W)}{dW} = \frac{-[V_{2}^{*}(U,W) - V_{2}(L,W) + V_{12}^{*}(U,W)]}{V_{11}^{*}U + 2V_{1}^{*}}.$$

By the second-order conditions for (2), the denominator of (8) is negative. Hence, the sign of (8) is determined by the numerator. We have the following result:

Result 1: If farmers' preferences exhibit decreasing absolute risk aversion at $\ell(W)$, the utility which the Nash solution assigns to environmentalists rises as W decreases.

Proof: To prove the result it suffices to show that the numerator of (8) is negative. Apply the envelope theorem to (2) to obtain

(9) $$V_1^*(U,W) = -\lambda$$

so that

(10) $$V_{12}^* = -\frac{\partial\lambda}{\partial W}.$$

Evaluating the appropriate expression in (5) establishes that expression (10) is nonpositive. (This follows by the second-order conditions and the strict concavity of u and V.) Applying the envelope theorem to (2) again gives

(11) $$V_2^*(U,W) = V_2(L - \ell(U,W),\ W + b(U,W)).$$

By definition $b(\ell(U,W),W) \leq b(U,W)$. The strict concavity of V then implies

(12) $$V_2(L - \ell(U,W),\ W + b(U,W)) < V_2(L - \ell(U,W),\ W + b(\ell(U,W),\ W)).$$

Finally, applying our lemma yields

(13) $$V_2(L - \ell(U,W),\ W + b(\ell(U,W),W)) < V_2(L,W).$$

Expressions (12) and (13) together with (10) imply the result■

Result 1 affirms our earlier intuition that environmentalists are better off bargaining with farmers who have suffered a wealth loss than bargaining with farmers who have not suffered a wealth loss. A natural supposition from Result 1 is that environmentalists were better off as a result of the farmer wealth loss because they were able to get farmers to retire more land. This intuition is confirmed by the following corollary:

Corollary 1: If $\ell(U,W)$ is normal and farmers' preferences are characterized by decreasing absolute risk aversion at $\ell(W)$, then $\ell(W)$ and $b(W)$ are decreasing in W.

Proof: Differentiate (6) to get

(14) $$\ell'(W) = \frac{\partial \ell(U,W)}{\partial U} \frac{\partial U}{\partial W} + \frac{\partial \ell(U,W)}{\partial W}$$

$$= \left(\frac{\partial U}{\partial W} - 1\right) \frac{\partial \ell(U,W)}{\partial U}$$

where the second equality follows from expressions (5). Use the definition of normality and Result 1 to establish the claim. Differentiating the second equation in (6) gives

(15) $$b'(W) = \frac{\partial b(U(W),\ W)}{\partial U} \frac{\partial U}{\partial W} + \frac{\partial b}{\partial W}$$

$$= \frac{\partial \lambda}{\partial W} \frac{\partial U}{\partial W} - \frac{\partial \ell(U,W)}{\partial u} u'(\ell)$$

where the second equality follows from results in (5). In the proof of Result 1 it was already established that λ is nondecreasing in W. Using the definition of normality and Result 1 establishes the claim■

Implications and Limitations

The results obtained validate our earlier intuition that a wealth loss by farmers would put them in a worse bargaining position and that environmentalists would gain provided that farmers' risk aversion is decreasing in wealth (in the sense defined). Although it is dangerous to draw firm policy implications from such a stylized model, the model can explain the stylized facts surrounding the CARP. Farmers being more risk averse than in earlier, wealthier periods found the CARP attractive not because it was an income-transfer or acreage-retirement program but because it gave them the chance to trade a risky asset (the right to farm the environmentally fragile acres) for a certain payment precisely in a period when their insurance premium was rising. (Remember, one can view the pre-CARP situation as one where the solution to the policy game is the Nash equilibrium.) Under these circumstances, it would not be surprising, *ceteris paribus*, if farmers would be willing to participate in an environmental-retirement program that they might not have found attractive otherwise. In other words, CARP is perhaps best thought of as an insurance program offered to farmers where ℓ is the premium.

A corollary to these results is that anything that would make farmers' wealth fall would leave environmentalists better off given that our assumptions hold. While the assumptions are, of course, stylized this recognition carries with it an important implication for environmentalist strategy in framing the agricultural-environmental debate. Environmentalists would do well to try to alter legally the wealth position of farmers. In terms of agricultural policy, a natural mechanism offers itself -- the income transfer programs associated with most commodity programs. If environmentalists can successfully lobby to get the payment streams from these programs lower, their capitalized value and hence farmer wealth would fall. Farmers then would be more willing to trade off the risky asset (ℓ) for the certain payment (b).

These results presume that farmers and environmentalists know each others risk preferences. If this is not true, our result would suggest that farmers would do well to convince environmentalists that their risk aversion is lower than it actually is. Sobel, in fact, has shown in a distortion game similar to the noncooperative policy game above where the strategy space is extended to include reported preferences to risk that an equilibrium strategy is for both farmer and environmentalists to represent themselves as risk neutral.

Of course, complete consideration of these latter issues greatly enlarges the strategy space available to farmers and environmentalists taking agricultural-environmental policy far beyond the limits of the rudimentary bargaining game considered above. But the implications are suggestive of the type of considerations that need to be considered in future formal analyses of agricultural-environmental policy formulation.

Concluding Remarks

This paper investigates how policy bargains between farmers and environmentalists are affected by the farmers' wealth posture. It was established in a Nash bargaining framework that a sudden erosion of farmer wealth enhances the position of environmentalists emerging from the Nash solution if farmer preferences satisfy a form of decreasing risk aversion. Environmentalists strike a better bargain with farmers: more environmentally fragile land will be retired and farmers receive a higher payment from environmentalists to retire the land.

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Footnotes

1. First-order stochastic dominance may be unrealistic because R refers to net return. It is maintained because it guarantees that Nash behavior for farmers (see below) is to set $\ell = 0$. This greatly reduces the mathematical clutter of the paper and facilitates graphical presentation of results. It can be formalized rigorously by imposing constant returns on the underlying technology and assuming that average revenue per acre exceeds cost per acre.

2. Convex distribution functions play an important role in the principal-agent literature on moral hazard and asymmetric information where they can be used to justify the first-order approach to these problems (Rogerson). Hart and Holmstrom contain a further discussion of the implications of convexity.

3. If the first-order stochastic dominance assumption is replaced and

$$\tilde{\ell} = \text{argmax} \int_{R^*} v(R + W)\, dG(R/L - \ell)$$

the Nash equilibrium becomes $b = 0$, $\ell = \tilde{\ell}$.

4. In all that follows, the Nash equilibrium refers to the equilibrium to the noncooperative policy game outlined above. The Nash solution on the other hand is the solution to the policy bargaining game that allows cooperation between farmers and environmentalists.

5. See Roth for an extended discussion of each of these properties. Also Binmore has recently shown how the Nash solution concept can be used with a further weakening of the independence of irrelevant alternatives to what he calls "convention consistency."

6. Of course, there is a clear difference between consumer theory and the present case. In the former, the characteristics of demand only depend upon one individual's preference structure. Here they depend upon both the environmentalists and the farmer's preference structure.

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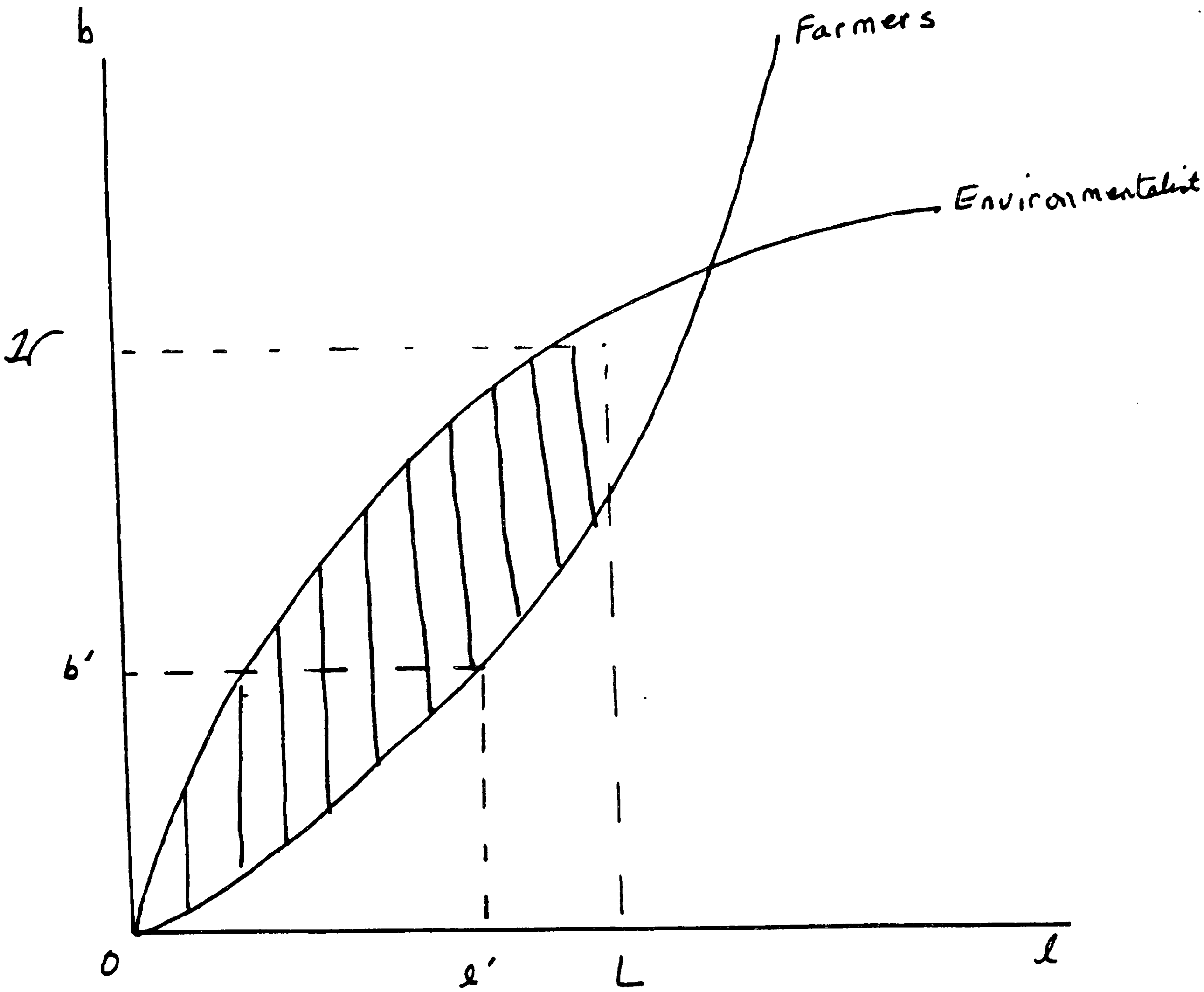

Figure 1

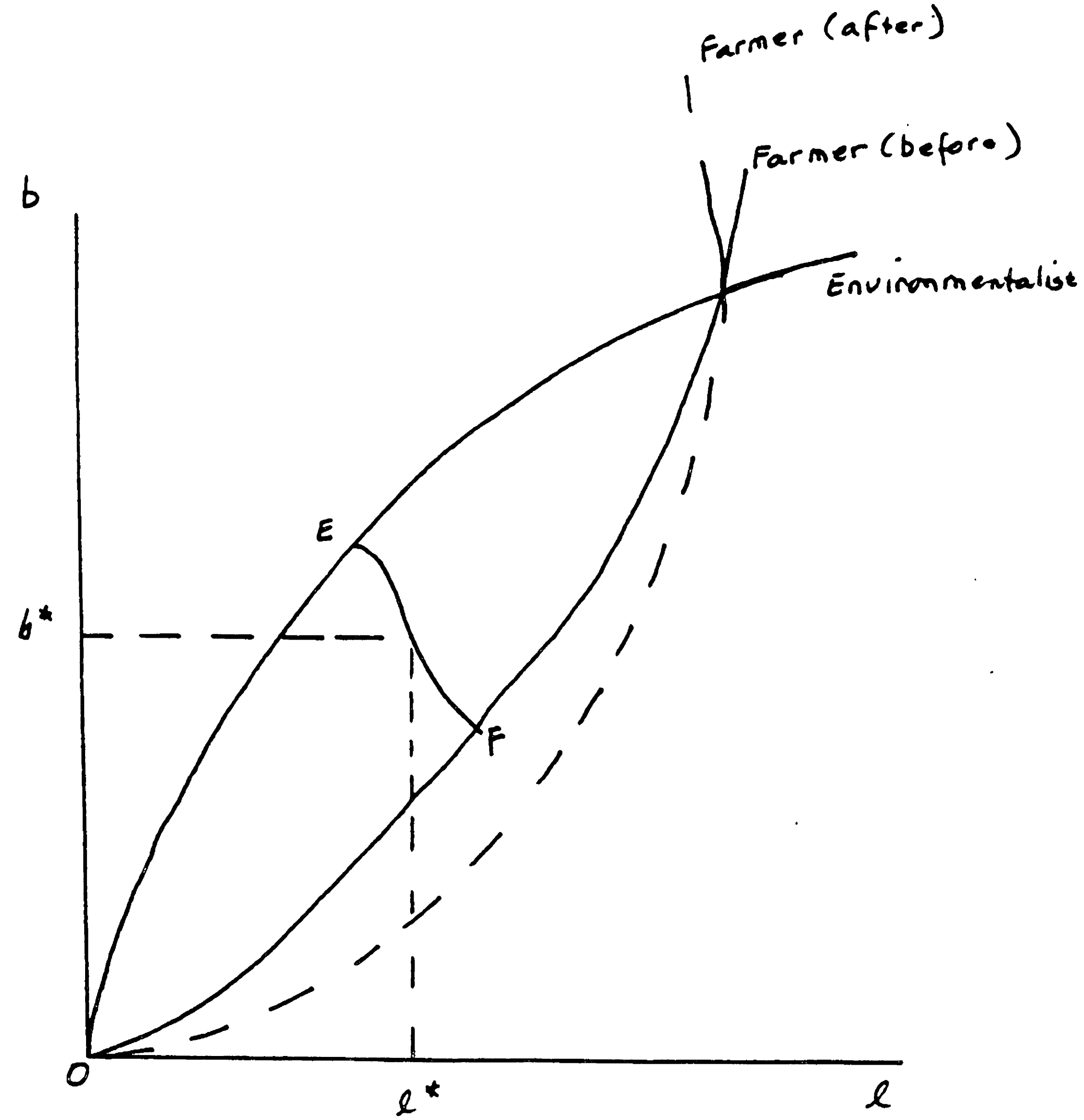

Figure 2

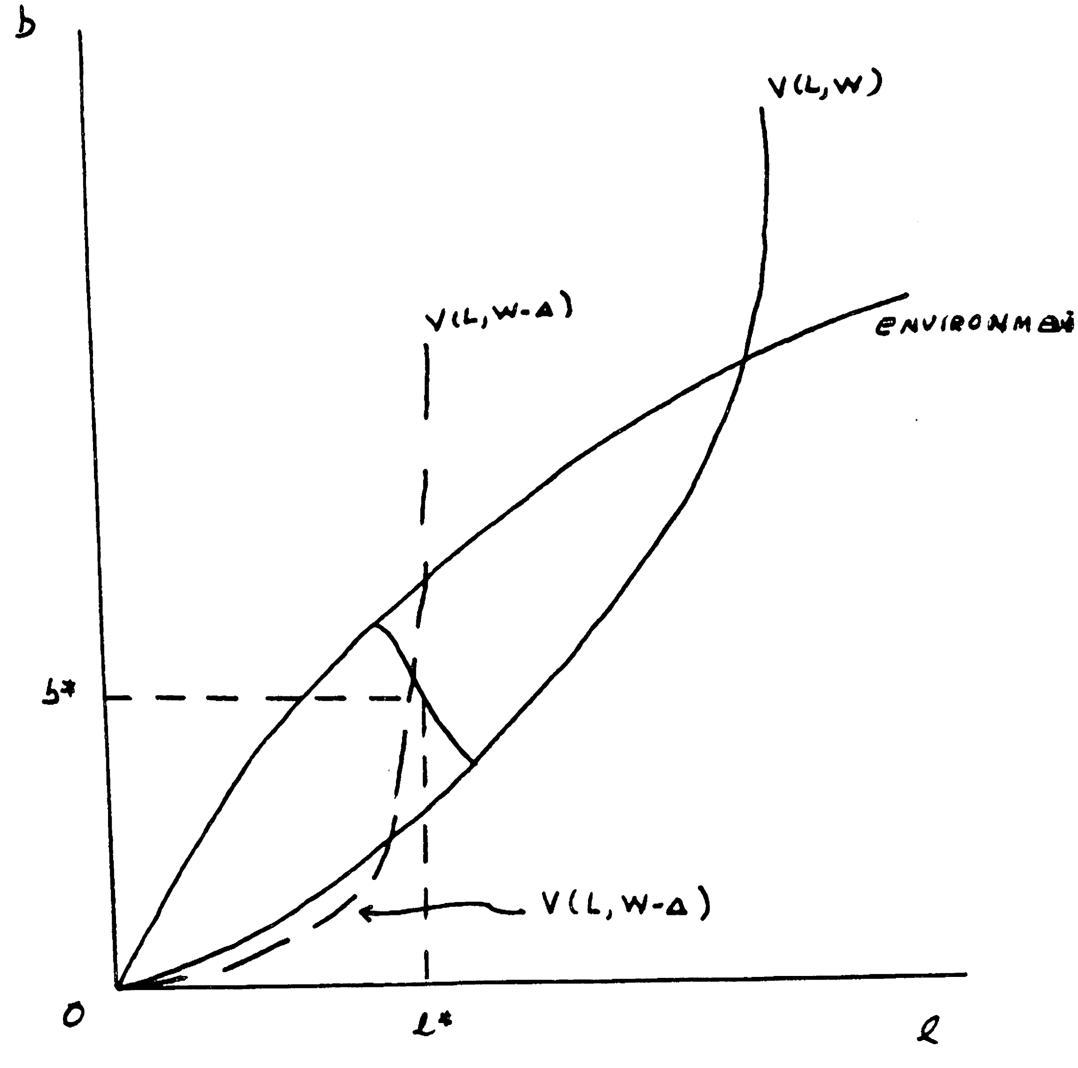

Figure 3

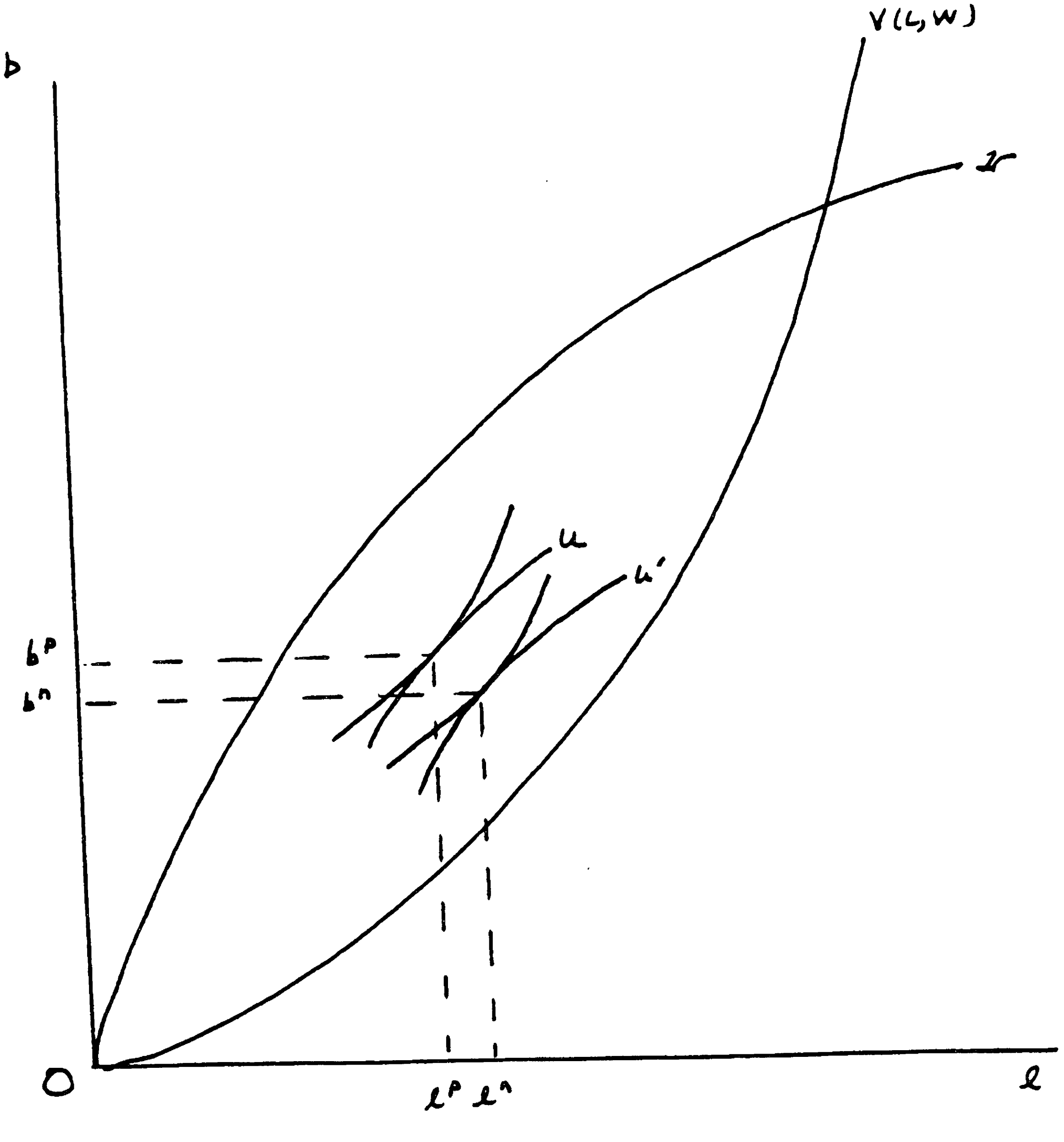

Figure 4

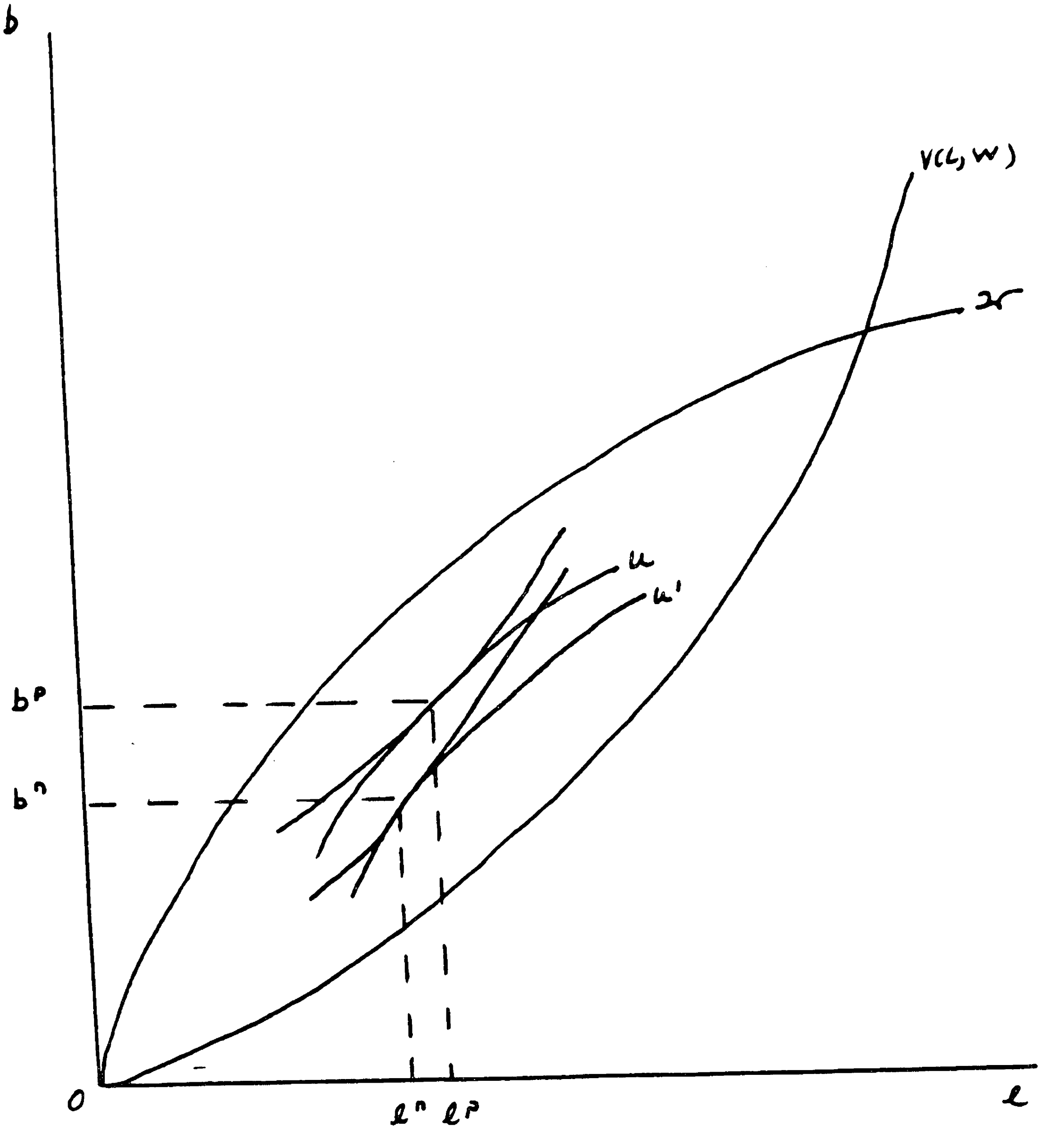

Figure 5