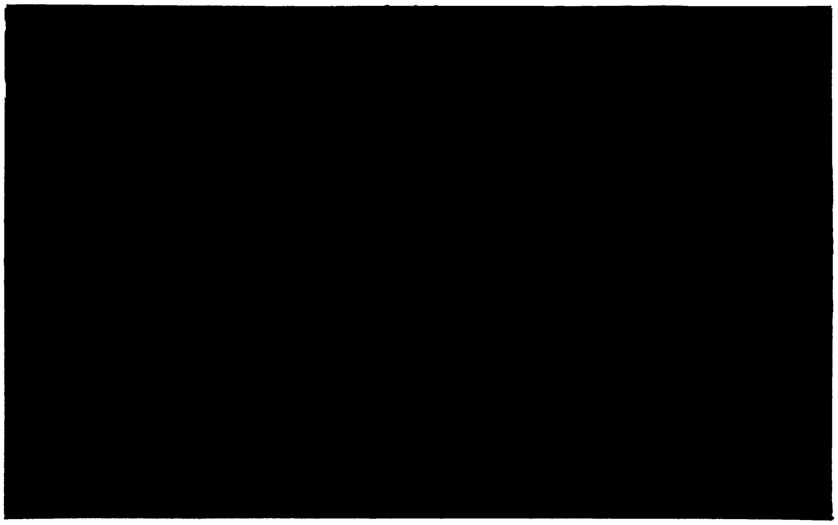
MD

WP 89-38

[redacted]

WORKING PAPERS

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
SYMONS HALL
UNIVERSITY OF MARYLAND
COLLEGE PARK 20742



On the Design of Agricultural Policy Mechanisms

by

Robert G. Chambers

Department of Agricultural and Resource Economics
University of Maryland
College Park, Maryland 20742

Working Paper No. 89-38

November 1989

On the Design of Agricultural Policy Mechanisms

In industrialized economies, a variety of mechanisms are used to redistribute income from taxpayers and consumers towards farmers. Developing nations, on the other hand, typically use agriculture as a tax base (World Bank). Agricultural policy mechanisms differ not only across countries but across commodities as well. Some commodities are protected by supply controls (U.S. tobacco, U.S. sugar, U.S. dairy), others receive direct or indirect production subsidies (U.S. wheat, U.S. coarse grains, U.S. rice, EC commodities subject to the variable levy, Japanese rice), others are subjected to export taxes (Argentinean wheat), and some a combination of both subsidies (taxes) and supply control.

Because different policy mechanisms have emerged in countries with obviously different agricultural policy goals, casual empiricism and common sense suggest that the policymaker's ultimate goal is intimately connected with the final policy mechanism choice. In many instances this connection is obvious: developing economies use tax mechanisms precisely because agriculture, being the dominant sector, must serve as the tax base for economies lacking the infrastructure needed for direct taxation. Other times the connection is more subtle. For example, developed countries often resort to simultaneous subsidies and supply control for the same commodity. The United States, in particular, has a long history of offering extremely high returns to producers of commodities whose production is controlled by the government. Recently the European Community turned to limited supply controls while still maintaining high domestic prices by a variable levy.

A traditional U.S. justification for a simultaneous subsidy-supply control agricultural policy is that agricultural demand is highly price

inelastic (Council of Economic Advisers, 1986). Thus, supply control can be seen as a way to capture monopoly rents, and the simultaneous subsidy could be the mechanism by which these rents are distributed to producers. This traditional explanation cannot apply in the glutted world agricultural markets that have characterized the last decade. But in a glutted world market, supply control might be viewed as a budget-saving device. Sometimes, it is cheaper to pay farmers not to farm than it is to dispose of surplus commodities.

This budgeting explanation for supply control begs an obvious question: if budget expenditures are excessive why not just reduce or eliminate the price incentive to overproduce instead of relying on supply control? As a case in point, the U.S. Food Security Act (FSA) of 1985 faced with large dairy surpluses and huge dairy expenditures introduced the Dairy Termination Program (DTP). The DTP paid farmers a bounty to retire from dairying (the bounty was partially financed by a levy on all dairy producers) for 5 years while either slaughtering their cows or selling them for export. Because the United States would be a net importer in the absence of its dairy programs (Council of Economic Advisers, 1986), the explanation for the DTP cannot be that the United States was pursuing monopoly rents in world markets. And if it only wanted to curb dairy program costs why not simply drastically lower the support price? (The support price was only lowered marginally). One explanation could be simply institutional rigidity in adapting policy mechanisms. But another explanation which is much less widely understood and, to my knowledge, has not been analyzed previously is that supply-control programs cum production subsidies favor particular types of farmers. Namely those farmers whose opportunity cost of foregone production is relatively low

-- the high cost, relatively inefficient producers.

This paper is a preliminary enquiry into the motivations underlying the choice of agricultural policy mechanisms. Formally, agricultural policy formation is viewed as a problem in mechanism design under asymmetric information. The approach, therefore, is distinct from other attempts to analyze optimal policy design (Gardner; Alston and Hurd) in that it uses on order principles of mechanism design. However, like these studies, it follows tradition and continues to focus on a single commodity. The goal is to sort through the motivations underlying the choice of a policy mechanism when the traditional argument for supply control (inelastic demand) is removed.

Although the treatment of agricultural policy follows by now relatively standard principles of mechanism design, there are important differences between the objective function used here and ones commonly used in firm regulation models with asymmetric information (see Caillaud et al. for a recent survey). Because a primary goal of agricultural policy is income redistribution, the model used is more properly associated with optimal taxation than firm-regulation models. So, even though the results are developed in the context of an agricultural policy problem, they extend to a class of optimal tax models of which the present is a special case. For example, Chambers (1989a) considers related issues in studying the optimal design of welfare/tax programs with regressive and progressive weighted utilitarian social welfare functions. And while the current focus is on the agricultural policies of industrial economies, the principles and framework developed extend to developing economies.

In what follows, we first specify the model. This is followed by a discussion of the properties of an optimally formulated agricultural policy that asks the question -- under what conditions is supply control second-best? The answer, which is related to general results on the targeting of transfer under asymmetrics information (Blackorby and Donaldson; Chambers 1989b), is: Supply control with simultaneous transfers can be second best even in the face of perfectly elastic demand if either the interests of less efficient (high-cost) farmers or budgetary concerns are weighted more by government than the interests of efficient (low-cost) farmers. (To demonstrate this result we remove by assumption the traditional motivation for supply control -- inelastic commodity demand). Conversely, overproduction (presumably through subsidies) is second-best when the interests of efficient producers receive more weight than the budget or less efficient producers.

The Model

For simplicity there are only two types of producers (efficient and inefficient) of an agricultural commodity. (The results are robust and extend to an arbitrary number of producer types.) Differences between efficient and inefficient farmers are solely technical.

Assumption 1: Farm types 0 (inefficient) and 1 (efficient) are ranked according to:

$$\partial C_1(q)/\partial q < \partial C_0(q)/\partial q$$

$$C_k\colon \mathbb{R}_+ \to \mathbb{R}_+ \text{ and } C_k \in C^1.$$

C_k is a strictly increasing and strictly convex cost function for farm type k evaluated at output q with

$$C_k(0) = 0 \qquad k = 0,1.$$

Without the program all producers produce a positive output; i.e.,

$$p - \partial C_k(0)/\partial q > 0 \qquad k = 0,1,$$

where p is the perfectly elastic price of the commodity.

Efficient farms have lower marginal and total cost over all outputs. All firms maximize profit and take the industry price as given. Implicitly we presume the existence of some fixed factors (e.g., entrepreneurial ability, access to government policies) which allow inefficient farm types to survive in the long run.

For observational, legal, and political reasons the government must treat both efficient and inefficient producers identically a priori. The same program alternatives must be available to all producers, producers freely choose their preferred alternative. There are two reasons for this assumption. The first is observational. When policies favor particular segments of society, unfavored segments try to appear to belong to the favored segment. Unless the policymaker can verify exactly to which group individuals belong, which they typically cannot, an incentive problem exists.[1] The second reason is that policymakers face societal and political pressures which typically make it impossible for them to favor overtly one farm group at the expense of another.

The government, therefore, must design a self-selecting mechanism. Because only two types of farmers are considered, discrete nonlinear pricing methods are appropriate (Guesnerie and Seade; Weymark). The government sets a policy menu consisting of 2 doubles (q_k, B_k) k = 0, 1 where q_k is the output level for the k^{th} farm type and B_k represents the net payments from the government accruing to a farm producing amount q_k. To allow for the possibility of producer-financed programs[2] and programs designed solely to tax farmers, B_k can be either negative or positive. Working in terms of (B_k, q_k) leaves unresolved just which mechanism is used to achieve the optimal allocation. But it is relatively easy to show that most traditional farm policies (subsidies, production limitations, etc.) can be viewed as particular mechanisms to achieve a given (B_k, q_k) allocation. For example, buying inefficient producers out of production as was the case with the DTP could correspond to the case where $B_0 > 0$ and $q_0 = 0$.

Isoprofit contours in (B,q) space for both firm types are illustrated in Figure 1. Assumption 1 insures that each firm's isoprofit contours are u-shaped (their slope is given by $\partial C_i(q)/\partial q - p$) and achieve their minimum where price equals marginal cost. Because their slopes are independent of B, isoprofit contours for different profit levels for the same firm are parallel. The cost efficiency differences embedded in Assumption 1 imply that efficient farm isoprofit contours through a particular point cut inefficient isoprofit contours through the same point from above (Figure 1).

A self-selecting mechanism must satisfy the incentive constraints:

$$\pi_0(q_0,B_0) \equiv pq_0 + B_0 - C_0(q_0) \geq pq_1 + B_1 - C_0(q_1) \equiv \pi_0(q_1,B_1) \text{ and}$$

$$\pi_1(q_1,B_1) \equiv pq_1 + B_1 - C_1(q_1) \geq pq_0 + B_0 - C_1(q_0) \equiv \pi_1(q_0,B_0).$$ [3]

Farm policies must also be individually rational: producers can never be worse off participating in farm programs than if they choose not to farm.[4] Hence,

$$\pi_0(q_0,B_0) \geq 0.$$

There is no need to require $\pi_1(q_1,B_1)$ to be nonnegative. Assumption 1 implies that efficient farmers can always make a strictly positive profit on any contract which at least breaks even for the inefficient producers.

We now state several results from the nonlinear-pricing literature which apply here:

Lemma 1 (Guesnerie and Seade, Weymark): The farm policy must satisfy

$$q_1 \geq q_0.$$

Lemma 2 (Whinston): Unless $q_1 = q_0$, only one incentive constraint can be binding, i.e., either

$$pq_0 + B_0 - C_0(q_0) > pq_1 + B_1 - C_0(q_1),$$

or

$$pq_1 + B_1 - C_1(q_1) > pq_0 + B_0 - C_1(q_0).$$

These lemmas are easily proved by adding the incentive constraints. Lemma 1 is interesting because it shows that the usual monotonicity properties associated with optimal tax structures, which are self-selecting, only apply in quantity but not budget space.[5] A self-selecting, farm policy mechanism uses quantity produced to screen producer types.

Lemma 2 shows that unless both types of producers produce the same amount one farm type always strictly prefers its policy alternative to the one for the other farm type. The exception occurs when $q_1 = q_0$. The incentive constraints can then be rewritten

$$B_1 \geq B_0, \text{ and}$$

$$B_0 \geq B_1.$$

If $q_1 = q_0$ then $B_1 = B_0$ -- both producers receive the same policy and are "bunched".

However, it is well-known from results in Guesnerie and Seade that when there are only two types bunching can never be optimal. For convenience we also state this as a Lemma.

Lemma 3 (Guesnerie and Seade): Bunching efficient and inefficient farmers is never optimal.

Because we consider the case of perfectly elastic demand, government intervention has no direct effect on consumers. Therefore we ignore consumer interests.[6] The policymakers' objective function is thus a weighted sum of producer incomes and budgetary costs. The weight the government attaches to the k^{th} firm type is denoted w_k; the weight the government attaches to the budgetary cost of the program is w_B. (A linear objective function is used only to reduce the computational aspects of the paper. Chambers (1989b) contains an algorithm for dealing with very general distributional objectives on the part of the government that go well beyond generalizing the current weights to nonlinear weighting schemes. And at the expense of increased computational complexity similar qualitative results will emerge. See also Chambers (1989a) for a related analysis.) Each w_i is nonnegative. Thus with g_k firms of type k, the government's objective function is:

$$\sum_{0}^{1} w_k\, g_k\, \pi_k(q_k, B_k) - w_B \sum_{0}^{1} g_k\, B_k .$$

A comment about the structure of the objective function is worthwhile. The assumption that the government attaches a negative weight to its deficit may seem odd at first blush. First the reader should be clear that I am only here talking about the government's budget for the agricultural program and not for its total budget: The budget can be roughly the same order of magnitude as farmer income. For example, in 1986 total expenditures on U.S.

farm programs were approximately $26 billion, while net farm income was approximately $30 billion. EC farm expenditures were of roughly the same order of magnitude.

As Gramm-Rudman legislation forces increased U.S.budget cuts and the EC faces a continuing crisis in its agricultural budget, including the budget in the objective function seems particularly plausible. It also allows the commodity program budget to be determined endogenously rather than as a parameter. This seems more realistic for two reasons: First, many price-support policies in Europe and the United States are basically entitlement programs and are not subject to any strict upper bound on budget expenditures. And second, while EC and U.S. agricultural programs enhance farm income, many developing countries use the agricultural sector as a source of tax revenue (World Bank). In such cases raising net tax revenue is an objective and one expects the government to weight net tax revenue ($-\sum_{0}^{1} g_k B_k$) very highly. When w_B is very large in the present model this is precisely what happens. The model contains as a special case ($w_B = 1$, $w_0 = w_1 = 0$) situations where the government acts as a monopolistic buyer of a commodity which is resold by the government at the prevailing world price.[7]

Analysis of the Model

Our focus is on how the underlying objective of agricultural policy affects the choice of the agricultural policy mechanisms. This requires relating the w_i parameters to policy mechanisms. For example, U.S. farm programs often pay producers not to produce and sometimes involve bribing producers to leave farming entirely. What w_i structure leads policymakers to bribe producers to quit farming? Other countries (e.g., Japan, Korea, and the European Community) design farm programs that result in production levels well above what prevailing market prices dictate (World Bank; Johnson, Hemmi, Lardinois). Are they pursuing the same goal as policymakers who bribe farmers to quit farming? These definitions will prove convenient.

Definition 1: An agricultural policy requires overproduction for farms of type i if $(p - \partial C_i(q_i)/\partial q) < 0$.

Definition 2: An agricultural policy diverts production for farms of type i if $(p - \partial C_i(q_i)/\partial q) > 0$.

Definition 3: An agricultural policy buys out producers of type i if $q_i = 0$.

Assume that a unique equilibrium exists and can be characterized by Lagrangian methods.[8] The Lagrangian expression is

$$L = \sum_0^1 w_i\ g_i\ \pi_i - w_B \sum_0^1 g_i\ B_i + \phi\pi_0(q_0, B_0)$$

$$+ \lambda\{\pi_1(q_1, B_1) - \pi_1(q_0, B_0)\} + \gamma\{\pi_0(q_0, B_0) - \pi_0(q_1, B_1)\}.$$

Function subscripts are suppressed when there can be no confusion and ϕ, λ, and γ are nonnegative Lagrangian multipliers. This Lagrangian expression is unbounded if the budget weight (w_B) is less than the average producer weight ($\bar{w}$) where

$$\bar{w} \equiv (w_0\ g_0 + w_1\ g_1)/(g_0 + g_1).$$

Intuitively, if w_B is smaller than $\bar{w}$ the government can always make its objective function infinitely large by making infinitely large lump-sum transfers from the budget to producers which preserve the incentive constraints but which run up an infinite budget deficit.[9] Therefore, Assumption 2: $w_B \geq \bar{w}$.

The first-order conditions for B_0 and B_1 require:

(1) $$\frac{\partial L}{\partial B_0} = w_0\, g_0 + \phi - \lambda + \gamma - w_B\, g_0 = 0$$

(2) $$\frac{\partial L}{\partial B_1} = w_1\, g_1 + \lambda - \gamma - w_B\, g_1 = 0$$

Solving gives:

$$w_B = \bar{w} + \phi/(g_0 + g_1).$$

Because ϕ is nonnegative, this expression implies that whenever $w_B > \bar{w}$, inefficient producers receive zero profit. If $w_B > \bar{w}$, then ϕ must be strictly positive which by complementary slackness requires the inefficient-farmer producer surplus to equal zero. For latter reference we state this in lemma form.

Lemma 4: If $w_B > \bar{w}$, then $\pi_0(q_0,B_0) = 0$.

The intuition is straightforward: if the government places a higher weight on the budget than the average producer, it transfers as little as possible to the average producer. The government wants to offer contracts that leave farmers with as little return as possible -- the inefficient farmers are left with no producer surplus. The government cannot leave efficient farmers with no producer surplus. Suppose it tries to while offering a (B_0,q_0) couple with $q_0 > 0$ but $\pi_0(B_0,q_0) = 0$. Efficient farmers can always adopt B_0,q_0 and make a positive profit by the following inequality

$$\pi_1(q_0,B_0) = pq_0 + B_0 - C_1(q_0) > pq_0 + b_0 - C_0(q_0) = \pi\ (q_0,B_0)$$

because $C_1(q_0) < C_0\ (q_0)$ for $q_0 > 0$. So if $w_B > \bar{w}$, $\pi_0(q_0,B_0) = 0$ but

$\pi_1(q_1,B_1) > 0$ if $q_0 > 0$.

We are now ready to characterize the second-best commodity policy (a proof is in the Appendix).

Proposition 1: The farm policy satisfies either:

(a) If $w_1 > w_B$ implying $(w_1 > w_B > w_0)$

$$pq_0 + B_0 - C_0(q_0) = p_1\ q_1 + B_1 - C_0(q_1);$$

$$p - \partial C_0(q_0)/\partial q = 0;$$

$$p - \partial C_1(q_1)/\partial q = \frac{(w_B - w_1)}{w_B}\left(\frac{\partial C_0(q_1)}{\partial q} - \frac{\partial C_1(q_1)}{\partial q}\right) < 0; \text{ and}$$

$$B_1 > B_0,$$
$$q_0 > 0,$$
$$q_1 > 0.$$

(b) If $w_1 = w_B$

$$p - \partial C_0(q_0)/\partial q = 0;$$
$$p - \partial C_1(q_1)/\partial q = 0;$$
$$q_0 > 0; \text{ and}$$
$$q_1 > 0.$$

(c) If $w_B > w_1$

$$pq_1 + B_1 - C_1(q_1) = pq_0 + B_0 - C_1(q_0);$$

$$p - \partial C_1(q_1)/\partial q = 0;$$

$$\left\{p - \partial C_0(q_0)/\partial q + \frac{(w_B - w_1)g_1}{w_B\, g_0}\left(\frac{\partial C_1(q_0)}{\partial q} - \frac{\partial C_0(q_0)}{\partial q}\right)\right\} \le 0$$

$q_0 \geq 0$;[10]

$q_1 > 0$; and

$B_0 > B_1$.

Proposition 1 lets us accomplish the primary goal of the paper -- relating policy mechanism characteristics analytically to the weighting structure of the decision maker. The first such result follows from Proposition 1 and Definition 2.

Corollary 1: Second-best program design never involves paying efficient farmers to divert production.

The only inefficiency that emerges for efficient farmers is over-production. And this only occurs when $w_1 > w_B$. Although one must draw inferences from such a stylized model carefully, one might then infer that farm policies geared to overproduction are policies to enhance the relative position of efficient farmers. Examples of mechanisms that achieve over-production are support or target prices much higher than prevailing market prices. For example, the EC variable levy has historically guaranteed EC producers prices well above the world price while the United States supports sugar prices at four to five times the world price. Other industrial nations (for example, Japan and Korea) also have pricing policies encouraging overproduction (World Bank).

Corollary 2: If $w_1 > w_B$ (implying $w_1 > w_0$), all farmers produce at least as much as in the absence of the program, and no individual farmer is bought out.

If $w_1 < w_B$ inefficient farmers divert production.

The intuition behind the first part of Corollary 2 is simple: Suppose $w_1 > w_B$. Because $w_B \geq \bar{w}$, $w_1 > w_B \geq w_0$. Policymakers want to transfer producer surplus to efficient producers. If possible, policymakers would prefer to finance this transfer by extracting producer surplus from inefficient farmers rather than by spending budget dollars. But if $q_0 = 0$ inefficient farmers create no producer surplus to be transferred to efficient farmers. Any transfer to efficient producers then must be financed solely from the budget. Because $w_B \geq w_0$, policymakers prefer inducing inefficient producers to produce a positive amount which creates a positive producer surplus which can be used to reduce budgetary outlays. The bottom line is deceptively simple. If the government wants to transfer producer surplus from inefficient to efficient producers it must first get inefficient producers to generate some producer surplus. This rules out buyouts. Corollary 2 suggests, for example, that the EC decision to move to supply control while keeping threshold prices high and the U.S. DTP were not meant to help more efficient farmers. For these policies to be justified as approximations to second-best policies, it must be in the context of budget concerns or helping inefficient farmers.

Diversion (supply control) is second best if the government's weight for efficient farmers is less than the budget weight. There are several reasons why this happens. If the government favors inefficient farmers ($w_1 < w_B < w_0$), it wants to transfer as much producer surplus to inefficient farmers as possible. Efficient farmers, therefore, must produce efficiently to create the largest possible pool of resources to transfer. If efficient farmers are also subsidized (as in the European Community and the United States), having efficient farmers produce efficiently makes the efficient farmer subsidy as small as possible and the budget transfer to inefficient farmers as big as possible.

Inefficient farmers, on the other hand, divert production. The self-selection constraints force the government to make the inefficient farmer contract unattractive to efficient farmers. Doing so requires reducing q_0. Because an efficient farmer's marginal cost is always less than an inefficient farmer's, diverting production is the best way to make a self-selecting contract unattractive to an efficient farmer. As output declines, the efficient farmer's marginal cost saving is small relative to the marginal cost saving of the inefficient farmer. Both lose the same marginal revenue in the market (the price is fixed at p) so that marginal profit losses of diverting production are higher for the efficient than for the inefficient farmer. The inefficient farmers' losses can thus be made up more easily by lump-sum transfers.

The second reason a policy may lead to production diversion is that the government may be trying to tax agricultural producers, i.e., $w_B > w_1$. In this case the government is trying to transfer as much producer surplus to itself as possible. It gains the most tax revenue at the margin by having efficient producers maximize producer surplus while inefficient farmers divert enough production to make the resulting mechanism incentive compatible. The results that emerge when $w_B > w_0$ may be usefully compared with those obtained under a monopolistic seller in the presence of asymmetric information (Maskin and Riley).

We now turn to an examination of cases where buyouts like the DTP may be second best.

<u>Corollary 3</u>: If $w_1 < w_B$, a buyout of inefficient farmers is only optimal if

$$p - \frac{\partial C_0(0)}{\partial q} < \frac{w_B - w_1}{w_B} \frac{g_1}{g_0} \left(\frac{\partial C_0(0)}{\partial q} - \frac{\partial C_1(0)}{\partial q} \right).$$

By lemma 4, if $w_B > \bar{w}$ then $\pi_0(q_0, B_0) = 0$. If the conditions of Corollary 3 are satisfied and $q_0 = 0$, then a buyout cum transfer payments (like the DTP) is possible when $w_1 < w_B$ only if $\bar{w} > w_B$ which means $w_0 > w_B > w_1$. And in this case it follows further that as w_0 increases relative to w_1 holding w_1, g_1, and g_0 constant that the right hand side of the inequality in Corollary 3 approaches by Assumption 2

$$\frac{g_1}{g_0} \left(\frac{\partial C_0(0)}{\partial q} - \frac{\partial C_1(0)}{\partial q} \right).$$

This expression is strictly positive. So for a program like the DTP to be second best requires more than just that w_0 exceed w_1 by a large amount. For suppose that g_0 was also large, this expression approaches zero which eventually implies that a buyout requires

$$p - \frac{\partial C_0(0)}{\partial q} < \varepsilon$$

where $\varepsilon > 0$ can be made arbitrarily small as g_0 increases. By continuity and Assumption 1, therefore, a g_0 must exist for which buyouts are not optimal. The reason, of course, is that as g_0 increases without bound so will the costs of the buyout $g_0 B_0$. Hence, if $w_1 < w_B$ a program like the DTP is more likely to be second best if there are relatively few inefficient farmers, cost advantages of efficient farmers are large, and $w_0 > w_B > w_1$.

The following result summarizes the feasibility of buyouts when $w_1 > w_0$ (note if $w_0 > w_1$, then $w_B \geq w_1$).

Proposition 2: If $w_1 > w_0$ a buyout is second-best optimal only if $w_B > w_1$. The optimal farm policy ($w_B > w_1 > w_0$) then satisfies

$$\Pi_0(q_0, B_0) = \Pi_1(q_1, B_1) = 0;$$

$$B_1 = -\max_q v_1(q);$$

$$B_0 = 0; \text{ and}$$

the value of the government's objective function is

$$w_B\, g_1 \max_q v_1(q).$$

where $v_1(q) = pq - C_1(q)$.

Proof: see Appendix

Buyouts only occur when efficient farmers are more heavily weighted than inefficient farmers under extreme conditions. Namely the program is not one to reallocate income within the agricultural sector. Instead it is a program to tax the most efficient producers out of all of their producer surplus and to turn this amount over to the government budget ($w_B > w_1 > w_0$).

Proposition 2 and Corollaries 1 and 2 imply production diversion is second-best even in the face of perfectly elastic demand if inefficient farmers weigh more heavily than efficient farmers in the government objective, or if the government is trying to tax agriculture. Production diversion thus signals $w_1 < w_0$ or $\bar{w} < w_B$. Although the latter case is likely relevant to many developing economies that downsize their agriculture to generate tax revenue, it probably has little applicability to industrialized economies. But the former case may be relevant to some commodity programs that limit supply even in the face of elastic world demand. Casual examples from the

U.S. farm sector include the DTP and tobacco which because of its production quotas, which are extremely small, has steadily lost world market share (Council of Economic Advisers, 1986, pp. 147-148).

Concluding Remarks

This paper uncovers a direct link between choice of farm policy tools and the redistributional preferences of agricultural policy makers. If policy-makers choose policy tools (mechanisms) which lead to overproduction (high support prices or large production subsidies), they favor efficient producer interests within the stylized model developed here. If they choose supply control mechanisms (acreage diversion, cow killing), their preferences are revealed to favor inefficient producers or the budget.

To conclude it is appropriate to mention some limitations and extensions of the model. The first extension is to consider nonlinear weighting. Intuitively, the better off decision makers make a particular group the smaller that group's marginal weight should become. Considering nonlinear weights, however, will inevitably make the results much less clear cut. But, as Chambers (1989b) shows, the basis structure of the results will continue to apply. Another obvious extension to the many producer case has already been discussed and summarized in several footnotes. From a more sectoral perspective, extension to an overarching multicommodity program would be very important because it would show how the interests of different commodities (grains vs. livestock) are traded off against one another.

Appendix

Proof of Proposition 1:

We start with a technical corollary

Corollary A.1: $\lambda\gamma = 0.$

Proof: By Lemma 2 and Lemma 3 only one incentive constraint can bind, therefore an immediate consequence of complementary slackness is that either λ or γ must equal zero.

Now a proof of Proposition 1. That $q_1 > 0$ in all cases follows from Lemmas 1 and 3 and the fact that $q_0 \geq 0$. The proof of (a), (b), and (c) are all parallel. Therefore, only (a) is established here; the extension is left to the reader. Denote producer surplus for a k-type farm

$$v_k(q) = qp - C_k(q).$$

First-order conditions are

$$\frac{\partial L}{\partial q_0} = (w_0\ g_0 + \phi)(p - \partial C_0(q_0)/\partial q) - \lambda(p - \partial C_1(q_0)/\partial q)$$

$$+ \gamma(p - \partial C_0(q\ )/\partial q) \leq 0;\ \text{and}$$

$$\frac{\partial L}{\partial q_1} = w_1\ g_1(p - \partial C_1(q_1)/\partial q - \lambda(p - \partial C_1(q_1)/\partial q)$$

$$- \gamma(p - \partial C_0(q_1)/\partial q) \leq 0,$$

with complementary slackness. Using (1) and (2) gives

$$g_0\ w_B(p - \partial C_0(q_0)/\partial q) + \lambda(\partial C_1(q_0)/\partial q - \partial C_0(q_0)/\partial q) \leq 0$$

$$g_1\ w_B(p - \partial C_1(q_1)/\partial q) + \gamma(\partial C_0(q_1)/\partial q - \partial C_1(q_1)/\partial q) \leq 0.$$

If $w_1 > w_B$ then by (2) $\lambda - \gamma < 0$ and Corollary A.1 establishes: $\lambda = 0$;

$-\gamma = (w_B - w_1)g_1 < 0$. If $\gamma > 0$ complementary slackness requires

$$\Pi_0(q_0, B_0) = \Pi_0(q_1, B_1)$$

which is the first equality. The second equality follows by $\lambda = 0$ and Assumption 1 implies $q_0 > 0$. To establish $B_1 > B_0$ observe that $v_K(q)$ by Assumption 1 is uniquely maximized where

$$v_k'(q) = p - \partial C_k(q)/\partial q = 0.$$

The second equality in (a), therefore, implies $v_0(q_0) > v_0(q)$ for all q. But since $\gamma > 0$ implies

$$B_0 + v_0(q_0) = B_1 + v_0(q_1)$$

one gets

$$v_0(q_0) - v_0(q_1) = B_1 - B_0 > 0.$$

This establishes (a).

Proof of Proposition 2:

By hypothesis $w_1 > w_0$, now presume counter to the Proposition that $w_1 > w_B$ but that $q_0 = 0$. Then $w_1 > w_B$ implies case (a) applies and $q_0 > 0$ contradicting the presumption. Thus, if $w_1 > w_0$ and $q_0 = 0$ then $w_B > w_1$. It then follows that $w_B > \bar{w}$ and Lemma 4 implies $\pi_0(q_0, B_0) = 0$. Now Assumption 1 implies that if $q_0 = 0$, $\pi_0(q_0, B_0) = 0$ only if $B_0 = 0$. Because $w_B > w_1$ expression (2) gives $\lambda - \gamma > 0$ and using Corollary A.1 gives $\lambda > 0$ implying

$$p - \frac{\partial C_1(q_1)}{\partial q} = 0; \text{ and}$$

$$pq_1 + B_1 - C_1(q_1) = pq_0 + B_0 - C_1(q_0)$$

$$= C_0(q_0) - C_1(q_0) = 0,$$

since $q_0 = 0$. This establishes the result.

References

Alston, J. and B.M. Hurd. "Some Neglected Social Costs of Government Spending in Farm Programs," American Journal of Agriculture Economics 72(1990): 149-56.

Ballard, C.L., J. Skoven, and J. Whalley. "General Equilibrium Computations of the Marginal Cost of Taxes in the United States," American Economic Review 75(1985):129-39.

Blackorby, C. and D. Donaldson. "Cash vs. In-Kind, Self-Selection, and Efficient Transfers," American Economic Review 78(1988).

Chambers, R.G. "Workfare or Welfare?" Journal of Public Economics 40(1989a): 79-87.

____________. "Concentrated Objective Functions for Nonlinear Tax Models," Journal of Public Economics 39(1989b):365-75.

____________. "Choosing Agricultural Policies: Should We 'Save the Cows'?" Working Paper #88-64, 1988.

Caillaud, B., R. Guesnerie, P. Rey, and J. Tirole. "Government Intervention in Production and Incentives Theory: A Review of Recent Contributions," Rand Journal of Economics 19(1988):1-26.

Council of Economic Advisers. Economic Report of the President; Executive Office of the President, Government Printing Office: Washington, D.C., 1986.

____________. Economic Report of the President; Executive Office of the President; Government Printing Office, Washington, 1987.

Gardner, B.L. "Efficient Redistribution Through Commodity Markets," American Journal of Agriculture Economics 65(1983):225-34.

Guesnerie, R. and J. Seade. "Nonlinear Pricing in a Finite Economy," Journal of Public Economics 17(1982):157-79.

Johnson, D.G., Kenzo Hemmi, and Pierre Lardinois. Agricultural Policy and Trade: Adjusting Programs in An International Framework, New York University Press (New York, 1985).

Katz, Michael. "Non-uniform Pricing, Output and Welfare Under Monopoly," Review of Economic Studies L(1983):37-56.

Maskin, E. and J. Riley. "Monopoly with Incomplete Information," Rand Journal of Economics 15(1984):171-96.

Weymark, J. "Comparative Static Properties of Optimal Nonlinear Income Taxes," Econometrica 55(1987):1165-1186.

Whinston, M. "Moral Hazard, Adverse Selection, and the Optimal Provision of Social Insurance," Journal of Public Economics 22(1983):49-71.

World Bank. The World Development Report 1986; Oxford University Press: Oxford, 1986.

Footnotes

1. An example from U.S. experience illustrates: U.S. commodity programs have limits on the amount that one farmer can receive in direct federal payments. This limit was set at $50,000. Substantiated reports of payments to individuals totalling in the millions have emerged (Council of Economic Advisers, 1987). Large farms were subdivided to permit each subdivided unit to qualify for the $50,000 payment.

2. Producer financed programs prevail in several U.S. markets. For example, the DTP discussed in the introduction was partially funded by a special tax levied on U.S. milk producers (Council of Economic Advisers, 1986).

3. With n (> 2) producer types the incentive constraints are replaced by

$$\pi_k(q_k, B_k) \geq \Pi_k(q_j, B_j) \text{ for all k and j.}$$

However, the analysis is greatly simplified by noting that assumption 1 (see e.g. Katz, Weymark) implies that these n - 1 constraints for each k can be replaced with the two constraints

$$\Pi_{k+1}(q_{k+1}, B_{k+1}) \geq \Pi_{k+1}(q_k, B_k)$$

$$\Pi_k(q_k, B_k) \geq \Pi_k(q_{k+1}, B_{k+1})$$

4. Many U.S. farm programs are entirely voluntary. In such instances, this constraint is unnecessary, and the problem needs to be restated in terms of all $B_k \geq 0$. By definition, however, this rules out completely producer financed programs (except for the obvious trivial exception $B_0 = B_1 = 0$) or programs designed solely to tax agricultural producers. Many programs entailing producer levies (the DTP entailed mandatory producer levies) are

not voluntary. Thus, in what follows we presume that all producers participate while noting that allowing for nonparticipation with nonzero production requires a slight change in the analysis.

5. The Guesnerie and Seade and Weymark models have feasible alternatives meeting the incentive constraints arranged in an ascending stair-step fashion to the northeast.

6. An earlier, longer version of this paper (Chambers, 1988) takes account of consumer interests when demand is not perfectly elastic. The basic results concerning the form of the optimal mechanism continue to apply.

7. Ballard et al. have calculated that the shadow price of one dollar of government expenditure in the United States is about .3. An alternative (and more usual) interpretation of the model is as the maximization of a weighted sum of producer incomes subject to a predetermined constraint on government program expenditures. With this interpretation w_B is a nonnegative Lagrangian multiplier. This interpretation is less general because it rules out situations where the government behaves monopsonistically as a special case. On the other hand this interpretation of the model is perhaps more natural when the sole goal of the program is to subsidize the agricultural sector.

8. This is a strong assumption because the incentive constraints define a nonconvex set. Its sole purpose is to justify the use of first-order conditions in analyzing policy mechanisms. At the expense of increased mathematical complexity the same qualitative results on the policy mechanism can be obtained by using Chambers' (1989b) extension of Weymark's reduced-form tax model. Also notice that the use of linear weights in the objective function implies that the convex hull of the

feasible set yields the same policy choices as the feasible set even when the feasible set is not convex.

9. Interpreting w_B as a Lagrangian multiplier, this implies that w_B is strictly positive. The government always totally exhausts its mandated budget in administering the program. If the government's budget is set to zero, i.e., the program is completely producer financed, then either the efficient or the inefficient farmer must be taxed on a net basis.

10. This notation is used to denote the usual complementary slackness condition associated with the Kuhn-Tucker conditions.

11. The analysis in this section generalizes to the case of n producer types. Basically if $w_B = \bar{w}$ and

$$w_n > w_{n-1} > \ldots > w_0$$

the optimal policy is to have the least efficient farmer (i.e., type 0) produce efficiently with all other farm types producing where marginal cost exceeds price; here, however, only the least efficient farmer makes zero profit, all others make a strictly positive profit when $q_0 > 0$. In all instances,

$$pq_{k-1} + B_{k-1} - C_{k-1}(q_{k-1}) = pq_k + B_k - C_{k-1}(q_k).$$

If $w_B = \bar{w}$ and

$$w_n < w_{n-1} < \ldots < w_0$$

then the most efficient farmers produce efficiently and all others produce at a point where price exceeds marginal cost and

$$pq_k + B_k - C_k(q_k) = pq_{k-1} + B_{k-1} - C_k(q_{k-1}).$$

Figure 1: Efficient and Inefficient Farm Isoprofit Contours