Working Paper Series

WORKING PAPER NO. 498

A POLITICAL-ECONOMIC RATIONALE FOR COUPLED WELFARE TRANSFER POLICIES

by

William E. Foster and Gordon C. Rausser

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

BERKELEY

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

University of California

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA

WORKING PAPER NO. 498

A POLITICAL-ECONOMIC RATIONALE FOR COUPLED WELFARE TRANSFER POLICIES

by

William E. Foster and Gordon C. Rausser

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
April, 1989

A Political-Economic Rationale for Coupled Welfare Transfer Policies

William E. Foster and Gordon C. Rausser*

*Assistant Professor, Department of Economics and Business, North Carolina State University, and Robert Gordon Sproul Chair Professor, Department of Agricultural and Resource Economics, University of California, Berkeley, respectively.

A Political-Economic Rationale for Coupled Welfare Transfer Policies

The existence of distortionary wealth transfers is currently viewed as the result of competition among pressure groups. In this model of the world (Gary S. Becker, 1983; A. Downs, 1957; A. Krueger, 1974; M. Olson, 1965; Sam Peltzman, 1976; George J. Stigler, 1971; and Gordon C. Tullock, 1967), groups wrestle over the potential wealth offered by an economic system, enjoying subsidies or suffering taxes in proportion to their relative political strengths. The political power of these rent-seeking groups depends, implicitly at least, on their attributes, such as the size of their memberships, their abilities to manipulate the news media, and most importantly their efficiency at overcoming the free-rider problem. An important element of this model is the limit to the potential wealth society can share defined by the ideal of freely operating markets. Politically-coerced transfers between groups necessarily waste some of this wealth. In short, wealth transfers flow to the politically strong at the expense of society as a whole.

This paper presents an alternative model where policies that increase total social welfare may have to be accompanied by wealth transfers, or they will not be implemented because of political opposition. A potentially winning group taxes itself in order to mitigate the losses suffered by another group whose political strength lies in its ability to veto a move from the status quo. If threatened with sufficient harm, the members of the latter group would form a blocking coalition that obstructs the implementation of new policies. Distortionary wealth transfers, compared to nondistortionary transfers, may actually serve the purpose of overcoming this veto more efficiently by targeting members of the losing group who suffer less because they can take advantage of the policy to some extent. In effect, the taxed group is in control of the choice of all policies, including the method of wealth transfer; and the subsidized group merely sets constraints on the feasible choices. Our model offers an alternative hypothesis to the traditional view of rent seeking: Wealth transfers flow to the politically weaker group (weaker in the sense that it loses in the move from the status quo), and these transfers serve to secure increases in total social welfare.

The basic idea is that the existence of unproductive wealth transfers cannot be isolated from a greater, more complicated mass of government activities—some promoting waste and others promoting the social good. Economic policies may be usefully divided into two types: (1) those which are meant to correct market failures, or provide public goods, and are ostensibly neutral with respect to their distributional effects and (2) those which are meant to redistribute wealth from one social group to another and are ostensibly unconcerned with efficiency. Following the model addressed by Gordon C. Rausser (1982), the former policies are referred to as political economic resource transactions (PERTs) and the latter as political economic-seeking transfers (PESTs). The distinction between the two types of policies is briefly summarized by the popular metaphor of the economy as pie: PERTs expand the size of the pie and PESTs allocate the portions served.

Expanding the social-welfare pie does not guarantee that everyone's portion will also grow. If social groups must cooperate, at least to some extent, then wealth transfers and increases in total social welfare are politically inseparable. A group that gains wealth through the political process will give up something in return, namely, an acquiescence to investment in public goods that is to its disadvantage. In other words, the PEST allows the PERT. And a group that gains from investment in public goods will accept the rent seeking by a group that suffers from the investment. The PERT allows the PEST. We concentrate on the latter case for two reasons. First, making wealth transfers an inducement (or bribe), in order to secure an increase in total social welfare, stands in striking contrast to the standard view of rent-seeking behavior. Second, we believe that this case is the most appropriate to explaining one of the more notable examples of persistent and seemingly wasteful government intervention: federal agricultural policy in the United States.

The transfer of wealth may appear as an inefficient, rent-seeking-based policy given that the public good is in place; but as a means of securing the welfare-increasing policy, the wealth transfer is a crucial and Pareto-improving component of general policy. An important point which follows from this notion is that the true social costs of PESTs cannot be measured in isolation. The benefit of what may be nominally a PEST may lie in the PERTs which it allows to exist. And similarly, the benefits of a PERT may be less than those observed directly. The PERT may carry with it social costs in terms of the inefficient transfer schemes necessary to assure the PERTs political viability.

The ideas in this paper have implications for many pie-expanding policies. To motivate and provide an intuitive basis, we consider the case of technological change in the U. S. agricultural sector where producer subsidies appear endemic. Public funding of the system of research and development (R&D) and dissemination of technical information is the most apparent source of social welfare gains from the expansion of agricultural production (e.g., Robert E. Evenson, Paul F. Waggoner, and Vernon W. Ruttan, 1979; Vernon W. Ruttan, 1982). Under certain circumstances (most notably an inelastic demand curve), consumers gain and producers lose *ceteris paribus* with the dissemination of R&D sponsored by the government. The marketplace would otherwise fail to provide this R&D activity, either because the associated benefits cannot be captured by private interests or because the minimal size and scope of the R&D effort are beyond the ability of private interests to undertake. Producers as a coalition would obstruct the innovation-producing system without some associated wealth transfer scheme in place. The question arises: What is the best means available to consumers/taxpayers to avoid the formation of an obstructing producer coalition?

There are a variety of transfer schemes, but they may be broadly categorized into two types: those which are not neutral with respect to production ("coupled" policies) and those which are neutral ("decoupled" policies). The existence of one or the other type may be explained by the same underlying model of potential producer unwillingness to accede to supply-expanding public goods.

Wealth transfers need not be equally shared by producers. Some producers are harmed less than the average because they can take greater advantage of the supply-enhancing technological advance. Wealth transfers weighted in favor of these *innovators* may then serve to break producer coalitions obstructing change with less expense to consumers and taxpayers: Those who expand production to a greater degree simply need less transfer payments to be made indifferent to the public dissemination of the advance.

Coupled policies target their transfers according to production levels. Therefore, a wealth transfer through a per-unit-output payment, which just makes innovators as well off as without the technological advance, will transfer less (per initial level of production) to those who will take less (or no) advantage of the introduced PERT. The popularity of coupled payments in agriculture especially may be explained by this property of targeting transfers from consumers to innovators, to those less harmed by the dissemination of the advance, and thus to those most cheaply divided from a coalition that might obstruct the change.

The drawback, of course, of coupled payments is that they draw out more production at a greater cost than the marginal value of the extra consumption. One of the costs, therefore, of being able to better target innovators is this associated overproduction. The superiority to consumers/taxpayers of a coupled, distortionary policy must be judged both by its cost-efficiency at making innovators indifferent to the PERT's equilibrium effects and by its tendency to encourage socially inefficient levels of production.

The key element from which this discussion proceeds is that consumers/taxpayers do not know *a priori* who each innovator is, although they may know the aggregate degree of supply expansion due to the dissemination of the technological advance. Because they do not know who is harmed less by the future change, and thus to whom to target payments in order to break obstructing coalitions, consumers/taxpayers must use some *a priori* rule to operate the PEST. The rule is either a decoupled, lump-sum, per-producer payment (or per some other fixed unit) given to all producers that just breaks the coalition or a coupled, per unit, output payment (or per some other producer-controlled variable) given to all units of production that, again, just breaks the coalition.

The main result of the paper concerns the conditions under which we may see a rational mixture of both public goods and distortionary transfers. Propositions 2a and 2b in Section III demonstrate that, in order for the consumer/taxpayer to prefer nonneutral transfers, the increased production level of the firm being made indifferent to the technological change must be sufficiently greater than that of the average firm in the industry. The price-responsiveness of production defines sufficiency in this case: the greater the price elasticity of supply, the greater must be an innovator's increase in production relative to the industry average in order to rationalize nonneutral payments.

Following the presentation of the paper's central ideas in Sections I, II, and III, we turn to examining two related issues: the question of government outlays and the case of an uncertain rate of future technological advance. In judging the optimal transfer scheme, the weight the government places on consumer gains from low prices may be less than the weight it places on expenditures, especially in times of budget deficits. Section IV investigates the conditions under which each transfer scheme is optimal from a taxpayer's perspective. Section V analyzes the case of uncertain rates of technological advance. We complicate the model to one where consumers establish both the system of R&D and the transfer scheme prior to the random shift in aggregate supply. Proposition 4 shows, for the case of uncertainty, that nonneutral transfers based on some targeted output price have an added disadvantage of potentially large and unnecessary (in *ex post* sense) treasury outlays. The concluding Section VI discusses the implications of the ideas and model laid out in this paper.

I. The Mix of Supply-Expanding and Wealth-Transferring Policies

We present the basic model here to introduce the concept of a mix of PERTs and PESTs as a means of spreading among consumers and producers the benefits of supply-expanding policies. We take up the question of which type of transfer scheme is superior to consumers and taxpayers (which for now we consider the same group) in the following section.

Suppose that a technological advance can be introduced at a cost to taxpayers of k dollars. Once introduced, the technological change is a public good to producers and each, competing with all others, will adopt it. Although we will relax later the assumption that all producers adopt the change in order to explain the choice between transfer schemes, for the moment we may act as if producers were monolithic. Represent aggregate supply as having a constant elasticity:

$$S(P) = \left(\frac{1}{c}P\right)^{\alpha}, \tag{1}$$

and let the technological change be represented by a proportional decrease in the marginal cost of producing some level Y.[1] That is, let the marginal cost before the advance be $MC = cY^{1/\alpha}$ and, after the change, be $MC(\hat{\theta}) = \hat{\theta}cY^{1/\alpha}$, where $0 < \hat{\theta} \leq 1$. Small $\hat{\theta}$ indicates "large" technological changes, and $\hat{\theta}$ near unity indicates "small" changes. The aggregate supply rotates outward:

$$S(P, \theta) = \frac{1}{\theta}\left(\frac{1}{c}P\right)^{\alpha}, \tag{2}$$

where $\theta = \hat{\theta}^{\alpha}$. Henceforth, without loss of generality, we take θ as the indicator of technological change.[2] Take a constant-elasticity demand curve, $0 \leq \beta \leq 1$,

$$D(P) = bP^{-\beta}. \tag{3}$$

Equilibrium price before and after the advance are

$$P_0 = (c^{\alpha}b)^{\frac{1}{\alpha+\beta}}$$

and

$$P_1 = P_0 = \theta^{\frac{1}{\alpha+\beta}}.$$

A producer's profits before and after the advance are

(4) $$\Pi_0 = \frac{1}{1+\alpha}\left(\frac{1}{c}\right)^{\alpha} P_0^{1+\alpha}$$

and

$$\Pi_1 = \Pi_0 \theta^{\frac{1-\beta}{\alpha+\beta}}.$$

Producers may obstruct the dissemination of the advance at a cost of $l\Pi_0$, where $0 \leq l \leq 1$. (This "lobbying cost" is for convenience only represented here as proportional to initial profits.) They will obstruct the change if the losses under the change, $\Pi_0 - \Pi_1$, exceed the cost of lobbying against it, $l\Pi_0$, or if

(5) $$B = \Pi_0(1-l) - \Pi_1 = \Pi_0\left[(1-l) - \theta^{\frac{1-\beta}{\alpha+\beta}}\right] > 0.$$

Consumer gains are measured by the Marshallian surplus between prices P_1 and P_0 less the cost of disseminating the advance:

$$R = CS - k = \int_{P_1}^{P_0} D(P)dP - k = \frac{bP_0^{1-\beta}}{1-\beta}\cdot\left(1-\theta^{\frac{1-\beta}{\alpha+\beta}}\right) - k.$$

If the consumer gain exceeds the cost of disseminating the changes and producers are willing to bear the costs of obstructing the change, then it may be in the consumers' and taxpayers' best interest to make up producer losses through some transfer scheme. The introduction of this PEST policy is necessary in order to return some of the benefits of the PERT policy to producers. The amount of the transfer need only be that which makes them indifferent to obstructing the change. That is, a successful transfer, in the sense that it overcomes the coalition against the change, is simply the amount of losses under the change exceeding the lobbying costs or B of expression (5).

If, however, the cost to the consumer of implementing the transfer scheme, say t, is large, then there could be levels of the technological change parameter, θ, such that the consumer surplus gain due to the change exceeds the dissemination cost, producers object (yet the cost of transfer is too great), and thus no PERT is implemented.

We may now characterize under what conditions the PERT and PEST, as we have described them, exist.

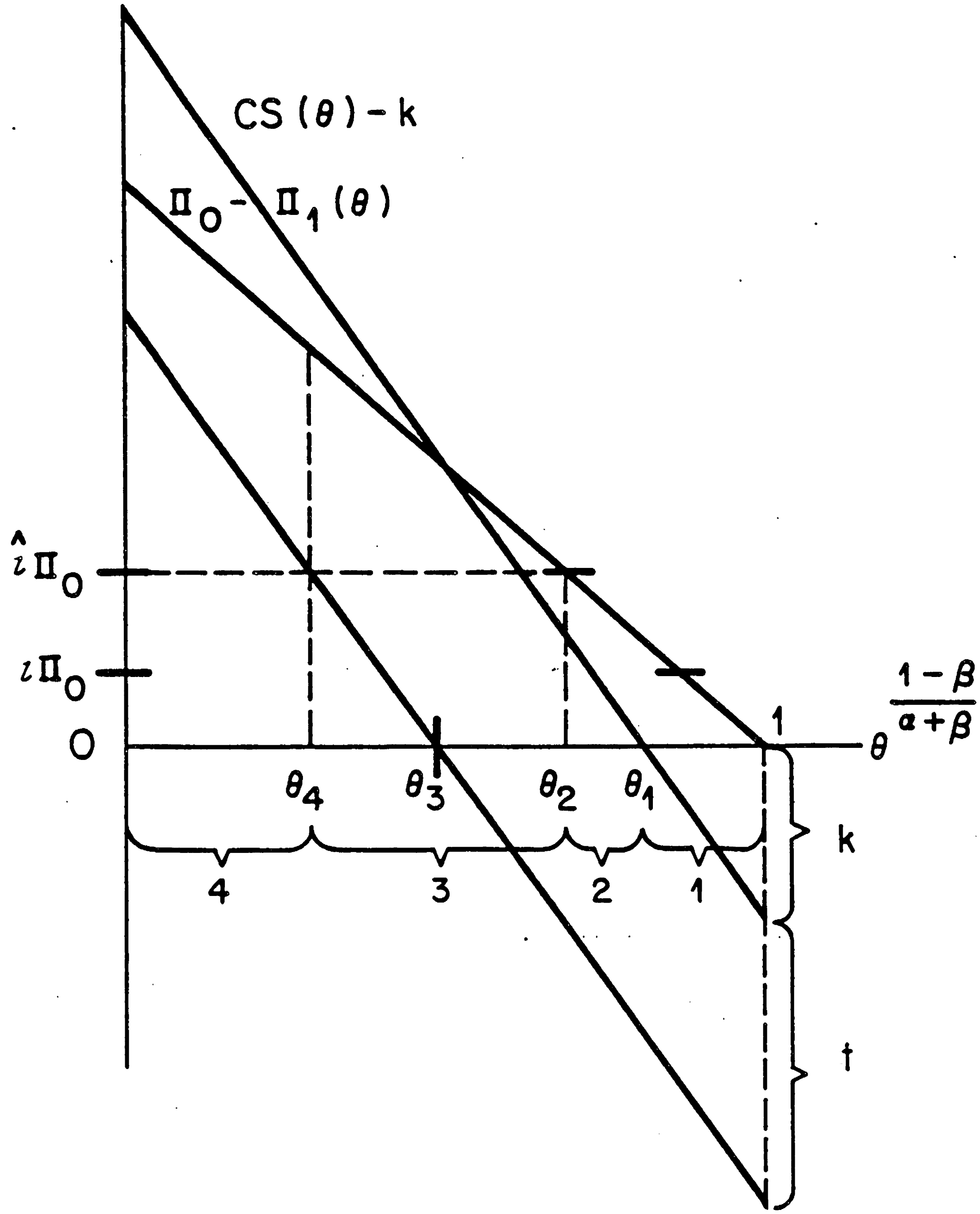
PROPOSITION 1a: *If the cost of producer obstruction is less than the producer loss at the level of technological change, θ, where the consumer is just indifferent to disseminating the change, or PERT, then there exist no levels of change where society's welfare (as measured by the sum of consumer and producer surpluses) is maximal. That is, if the PERT exists, it is accompanied by the PEST.*

This straightforward proposition may be demonstrated as in Figure 1. The line $CS(\theta) - k$ falls negative for some $\theta > \theta_1$. At θ_1, the consumer is just indifferent to implementing the PERT. The line $\Pi_0 - \Pi_1(\theta)$ represents the losses to producers of implementing a change of level θ. Clearly, if the lobbying cost, given by the line $l\Pi_0$, is such that $\Pi_0 - \Pi_1 > l\Pi_0$ for all $\theta > \theta_1$, then any technical change of level $\theta < \theta_1$ will not be implemented, because consumers will decline it, and any change of level $\theta > \theta_1$ will involve a transfer policy with implementation costs t.

A more interesting situation arises where consumers/taxpayers are prepared to bear the cost of implementing the technological change, but producers are unwilling to obstruct.

PROPOSITION 1b: *If the producer lobbying costs are* (1) *greater than producer losses at the level of advance where consumers are just indifferent to disseminating the technology but* (2) *less than producer losses at the level of advance where consumers are indifferent to implementing the transfer scheme, then there exist four regions of policy combinations as the level of technological advance moves from small to large:*

FIGURE 1. THE MIX OF PERTs AND PESTs UNDER VARIOUS LEVELS OF TECHNICAL CHANGE.



Region 1. No dissemination of the advance (no PERT).

Region 2. Dissemination without wealth transfers (PERT alone).

Region 3. No dissemination (no PERT).

Region 4. The combination of both the dissemination and the compensating wealth transfers (both PERT and PEST).

This proposition can also be demonstrated as in Figure 1. Consider a higher lobbying cost $\hat{l\Pi}_0$ such that the producer will be just indifferent to obstructing a technological change of level θ_2. This lobbying cost is chosen such that θ_2 lies above the level θ_3 where consumers are just indifferent to implementing both the PERT and the PEST. Consumers/taxpayers, however, will be unable to successfully transfer any benefits to producers at levels of $\theta > \theta_4$. Only for values of θ such that $CS(\theta) - k - t > B(\theta)$ will transfer schemes be successful. The four regions may be described in terms of Figure 1. Values of θ above θ_1 will produce no dissemination (region 1); for values between θ_2 and θ_1, a pure PERT will exist (region 2); for values between θ_2 and θ_4, producers will obstruct the PERT and consumers will be unable to successfully implement a PEST (region 3); and for values less than θ_4, the consumer will implement both PERT and PEST.

The purpose of this discussion is to demonstrate that there exist fairly simple conditions under which consumers/taxpayers may wish to engage in costly wealth transfer policies in order to enjoy the benefits of some supply-expanding policy. The necessity of such a transfer scheme depends both on the harm suffered by producers due to the equilibrium effects of the technological advance and on the cost of obstructing the advance's dissemination. As the demand curve grows less inelastic (i.e., as $\beta \rightarrow 1$), then the equilibrium effects grow less harmful to producers, and the value of the technological change for which transfers are a necessary accompaniment grows greater ($\theta_4 \rightarrow 0$). And similarly, as the cost of producer obstruction grows greater, the larger the range of supply expansion over which consumers may benefit from the technological advance without needing to share those benefits with producers.

Finally, if we think of losses to producers as due to transition costs that arise in the short run, then we are moving to a model where the rate of technological advance is endogenously determined in political-economic markets. Either systems of R&D are designed to produce technological progress at a slow rate, where the cost to producers is not too great to warrant their obstruction (region 2), or they are designed to produce progress at a fast rate, offering consumers large enough benefits to share with producers in order to gain their acquiescence to the pace. Systems that produce rates of technological advance in the middle range (region 3) would not be politically sustainable.

II. The Best Means of Wealth Transfer

Given that a transfer scheme is in the consumer's best interest, the question becomes that of determining the least costly means of breaking potential blocking coalitions. We narrow our attention to *a priori* rules that affect the coalition-breaking transfer. We may think of such rules as being announced at the same time as the promised consequences of the technical advance but prior to the actual dissemination of the advance. And indeed, this is approximately the situation in the case of agriculture in the United States, where rules of wealth transfers are in place and where aggregate growth of production is anticipated to be supported by a structured and on-going system of R&D and dissemination. Aggregate production is expected to grow due to future innovations and discoveries, the particulars of which are unknown to all but perhaps a few. At times, the anticipated effects on production of an advance are publicized well before the actual technological knowledge is available to implement those effects. The development of engineered bovine growth hormones is a case in point, where producers for many years have been informed of the eventual effects of the new technology, and have been anticipating both the aggregate and farm-level consequences of its dissemination.

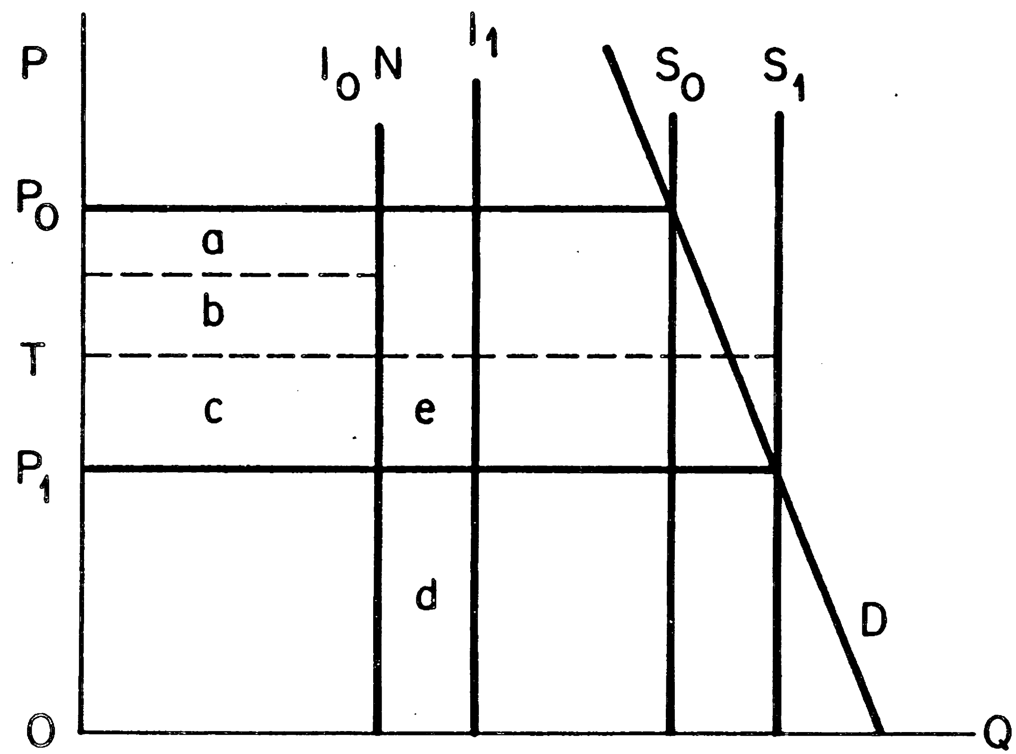
Of *a priori* rules, we consider two simple schemes: (1) a nondistortioning, per-producer payment (promised to all producers) and (2) a distortioning, per-unit payment (promised to all units of production). The first type of transfers are *decoupled* payments and are currently enjoying a vogue among some politicians and economists commenting on agricultural policy. (We shall assume that all producers are identical *before* the dissemination of the technological advance, having the same firm size, and so forth. If firm size is allowed to vary, the lump-sum compensation may be redefined to allocate payments on some standard, such as initial production levels, that producers are unable to manipulate.) Decoupled payments are meant to approximate the Holy Grail of lump-sum transfers. The second type of transfers are, by contrast, *coupled* payments. These are representative of the reality of past transfers to producers of the major agricultural commodities.

The key feature of these *a priori* rules is that they are generic in the sense that they do not distinguish directly between producers, specifically between innovators and noninnovators. Taxpayers do not target payments to specific producers in order to break the blocking coalition either because there exist high transaction costs to the identification of innovators or because there exist political constraints to transfers based on overly specific criteria. Although a successful level of either per-firm or per-unit payments must be such that the innovators are at least indifferent to the dissemination of the technical advance, the use of per-unit payments certainly is worse for noninnovators. While per-unit-output payments do not directly target a group, they in effect tend to concentrate transfers on those who make use of the supply-expanding technology. The cost to consumers/taxpayers of narrowing transfers to the disadvantage of noninnovators is the inefficient production level brought about by a producer price higher than the market-clearing price.

Returning to the one-producer model above, this inefficiency implies that the conditions under which a coupled policy can successfully transfer the coalition-breaking amount to the producer are stricter than a simple lump-sum policy. In the one-producer case, there are no noninnovators to exclude from payments; to the consumer, the lump-sum, decoupled policy dominates the per-unit policy because some potential gains would be needlessly dissipated by coupled payments in the form of inefficient production. Therefore, under these conditions, the existence of coupled rather than decoupled schemes may be explained in two ways. First, coupled schemes may be simpler to implement, being often merely a price which the government guarantees to producers. The government can simply stand willing to purchase at some price from producers all they want to sell. For example, it is easier to identify a unit of wheat than a legitimate producer who might join an obstructing coalition. Second, decoupled schemes may be too obvious: Coupled transfers are "hidden" or less transparent. This idea is based on a somewhat tenuous assumption that groups (or subgroups) of consumers that would obstruct a transfer costly to them, and thus obstruct the technical advance by which they would gain insufficiently, are rendered ineffective by transfer schemes more complicated than the simple writing of government checks.

Allowing heterogeneous producers into the model, however, is a third--and we would argue a major--reason for consumer choice of coupled policies in a portfolio of PERTs and PESTs. Consider the example illustrated in Figure 2. This is an extreme case of two types of producers, innovators, and noninnovators who must be unanimous in opposition in order to obstruct the dissemination of a technical advance. Initially, their individual supply curves are identical, perfectly inelastic, and are given by the curves labeled I_0 and N. Aggregate supply is given by $S_0 = I_0 + N$; demand by D; and initial equilibrium price by P_0. Now if the technical advance is implemented, innovators would have the new supply curve of I_1; the new aggregate supply would be $S_1 = I_1 + N$; and the new equilibrium price would be P_1. Both types of producers would lose rents given by area $a + b + c$ due to the fall in equilibrium price. Innovators, however, would gain by area d due to expanded production. Here area a is defined to equal area d. The potential net loss to innovators is, therefore, area $b + c$, which must be the least per-producer

FIGURE 2. THE OPTIMALITY TO CONSUMERS OF COALITION-BREAKING PER-UNIT-OUTPUT PAYMENTS UNDER PERFECTLY INELASTIC SUPPLY.



Note: $S_1 = I_1 + N$, $I_0 = N$

payment promised in order to prevent obstruction of the technical advance. The total consumer transfer to producers of $2(b + c)$ would leave the innovator just as well off as without the advance. The noninnovator would be a net loser of area a--the output-expanding benefit to the innovator.

Consider now the use of a "target" price that, when announced prior to the implementation of the technical advance, would guarantee to innovators that they would remain as well off as without the advance. This level of this producer price, T, is such that area b equals area e. The area e can be interpreted as benefits which the technical advance enables the innovator to gain in response to the target price. With the coupled policy, the innovator loses area $a + b + c$, due to the price fall, gains area d due to the technical advance, and gains area $c + e$ due to the support price. The noninnovator, however, gains only area c from the support price, implying a net loss of area $a + b$ with the coupled policy. Under the coupled policy, consumers need only transfer the amount of $2c + b$ to producers in order to gain the benefits of technical advance. A coupled policy in this case of perfectly inelastic supply curves benefits consumers by the amount b relative to the decoupled policy.[3]

This example clearly demonstrates that coupled transfer schemes distinguish those who would lose less under output-expanding changes in production. Coupled transfer schemes are better targeted at those who are the most easily divided from the obstructing coalition.

The case of inelastic supply curves and the similarity of innovators and noninnovators are the special features of this example that make so apparent the superiority of a per-unit transfer policy. As the proportion of innovators grows large, the relative consumer gain from using per-unit rather than per-firm payments declines. At the extreme where all identical firms would adopt the technology, then the total amount of transfers is the same under both types of policies; and under perfectly inelastic supply curves, the consumer would be indifferent between either scheme.

With perfectly inelastic supply curves, although the support price policy is coupled to the level of production, it is not a distortionary policy. In this sense it is decoupled from production decisions because production is divorced from all price considerations. And in this sense there is no cost of distinguishing innovators and noninnovators with a coupled policy. As the supply curves move from being perfectly inelastic to having some price responsiveness, the cost of the transfer, in terms of inefficient production, grows.

There are, therefore, two elements crucial to determining for consumers the best means of transferring benefits of the PERT to producers, that is, the best PEST: the relative proportion of innovators to noninnovators and the responsiveness of supply to coupled policies.

III. A Model of Coalition Breaking with Innovating and Noninnovating Producers

Consider that there are two types of producers--innovators who would make use of a future technical advance and noninnovators who would not. Let the proportion of *innovators* be given by λ and the proportion of *noninnovators* be given by $(1 - \lambda)$.[4] Let the initial supply and profit functions of both types of producers be given by expressions (1) and (4) as introduced in the preceding section. Again, consider a technological advance that shifts innovators' supplies at every price by the proportion $1/\theta$. An innovator's supply curve after the technical advance is given by expression (2).

Taking the constant-elasticity demand curve given by expression (3), the equilibrium price, P_1, is given by

$$S_1 = \frac{\lambda}{\theta}\left(\frac{P_1}{c}\right)^{\alpha} + (1-\lambda)\left(\frac{P_1}{c}\right)^{\alpha} = bP_1^{-\beta}$$

implying

$$P_1 = P_0\left(\frac{\theta}{Z}\right)^{1/(\alpha+\beta)} ,$$

where P_0 is the equilibrium price without the dissemination of the advance and $Z = \lambda + (1 - \lambda)\,\theta \leq 1$. The term Z may be given an intuitive meaning by noting that the percentage gain in an innovator's yield over the average yield of all producers can be expressed as

$$\frac{1}{\theta}\left(\frac{P_1}{c}\right)^{\alpha} / S_1 - 1 = \frac{1}{Z} - 1.$$

The term Z is a measure of how well one can distinguish innovators from all other producers through production levels. As Z falls, an innovator's production level grows relative to the average production in the industry.

Once the advance is adopted, an innovator's profit is given by

$$\Pi_I = \frac{1}{\theta}\left(\frac{\theta}{Z}\right)^{\frac{1+\alpha}{\alpha+\beta}} \Pi_0.$$

Again, take the cost of lobbying in order to obstruct the dissemination of the technical information to be proportional to initial profits, $l\Pi_0$. The consumers/taxpayers will find it necessary to compensate at least the innovator if his profits fall below that which he could obtain by obstructing the change:

$$\Pi_0 - l\Pi_0 > \Pi_I\,(P_1),$$

implying

(6) $$B_d = \Pi_0\left[(1 - l) - \frac{1}{\theta}\left(\frac{\theta}{Z}\right)^{\frac{1+\alpha}{\alpha+\beta}}\right] > 0.$$

This implies that, in order for transfers to be necessary, the level of technical change and the number of innovators must be such that

(7) $$Z\,(1-l) \geq \left(\frac{\theta}{Z}\right)^{\frac{1-\beta}{\alpha+\beta}} .$$

The intuition behind expression (6) is that, for a transfer scheme to be necessary, the residual demand facing the innovators must be sufficiently inelastic such that the price effect of the technical change is greater than the cost savings. For a given level of the advance, θ, as the proportion of innovators increases, the more inelastic is the residual demand facing that group, the greater price is depressed, and the more likely is compensation necessary to avoid obstruction.

Under a decoupled policy, announced prior to discovering innovators, based on lump-sum, per-producer payments, the minimum total amount of wealth transfer, B_d, is given by expression (6). Gross consumer benefits of the technical advance with the decoupled policy, CS_d, is represented by the area under the demand curve between prices P_0 and P_1:

$$CS_d = \frac{bP_0^{1-\beta}}{1-\beta} \cdot \left[1 - \left(\frac{\theta}{Z}\right)^{\frac{1-\beta}{\alpha+\beta}}\right].$$

Net consumer gains from the advance are represented by $R_d = CS_d - B_d$.

The coupled policy is a "targeted" price T, guaranteed to all producers, that will make the innovator just indifferent to obstructing the change:

$$\Pi_I(T) = \frac{1}{1+\alpha}\,\frac{1}{\theta}\,\frac{T^{1+\alpha}}{c^{\alpha}} = \Pi_0(1-l),$$

implying

$$T = P_0[\theta\,(1-l)]^{1/(1+\alpha)}.$$

The coupled policy will induce a greater level of production from all firms, implying a new equilibrium price, P_t, given by

$$bP_t^{-\beta} = S_t = \left(\frac{T}{c}\right)^{\alpha} \frac{Z}{\theta},$$

$$P_t = P_0 \cdot \left[[\theta(1-l)]^{\alpha/(1+\alpha)} \frac{Z}{\theta} \right]^{-1/\beta}.$$

The total transfers to producers under the per-unit payment scheme are given by

$$B_c = (T - P_t) S_t,$$

which after some algebraic manipulation may be represented as

$$B_c = \frac{P_0^{1+\alpha}}{c^{\alpha}} \left[(1-l) Z - \left[[\theta(1-l)]^{\alpha/(1+\alpha)} \cdot \frac{Z}{\theta} \right]^{-(1-\beta)/\beta} \right].$$

Gross consumer benefits from the coupled policy, CS_c, is given by the area under the demand curve between P_0 and P_t:

$$CS_c = \frac{bP_0^{1-\beta}}{1-\beta} \left[1 - \left[[\theta(1-l)]^{\alpha/(1+\alpha)} \cdot \frac{Z}{\theta} \right]^{-(1-\beta)/\beta} \right].$$

Net consumer/taxpayer benefits from the coupled policy are given by $R_c = CS_c - B_c$.

We may now characterize the conditions under which consumers/taxpayers would prefer coupled to decoupled policies. As the previous section's discussion anticipated, the crucial determinants of the superiority of coupled policies are the relative proportion of innovators and the price responsiveness of supply.

PROPOSITION 2a: *It is sufficient that the percentage gain in an innovator's level of production over the industry average is greater than the supply elasticity for consumers/taxpayers to prefer a coupled transfer of an additional marginal amount to* *producers. That is, if* $1/Z - 1 > \alpha$, *the consumers would prefer to give an additional dollar to innovators through coupled rather than decoupled means.*

PROOF:

For familiarity here, let the total number of producers be arbitrarily represented by N. The total amount at the margin that the consumer expends on the coupled program could be distributed evenly across all producers in the decoupled, per-producer payment scheme. If the per-producer amount transferred to innovators by this decoupled means $(\partial TS_t/\partial T)\ (N^{-1})$ is less than the per-producer transfer to innovators by the target price $(\partial \Pi_I/\partial T)$, then the decoupled policy is clearly inferior because the consumers can accomplish at least the same transfer to innovators by the coupled means and also gain some value due to the additional consumption.

The increase in consumer/taxpayer expenditures for an increase in the support price is given by

$$\frac{\partial TS_t}{\partial T} = (1+\alpha)\left(\frac{T}{c}\right)^{\alpha} \cdot \frac{Z}{\theta} \cdot N\ .$$

This increase in expenditures can be directly transferred through a decoupled program and increase each innovator's welfare by $\partial TS_t/\partial T = (1+\alpha)\ (T/c)^{\alpha} Z\theta^{-1}$. The associated increase in each innovator's profit with the coupled policy is given by $\partial \Pi_I/\partial T = (T/c)^{\alpha}\theta^{-1}$. From the immediately preceding paragraph, the decoupled policy is clearly inferior if

$$\frac{\partial TS_t}{\partial T} \cdot \frac{1}{N} < \frac{\partial \Pi_I}{\partial T},$$

or if $1/(1+\alpha) > Z$, or $1/Z - 1 > \alpha$.

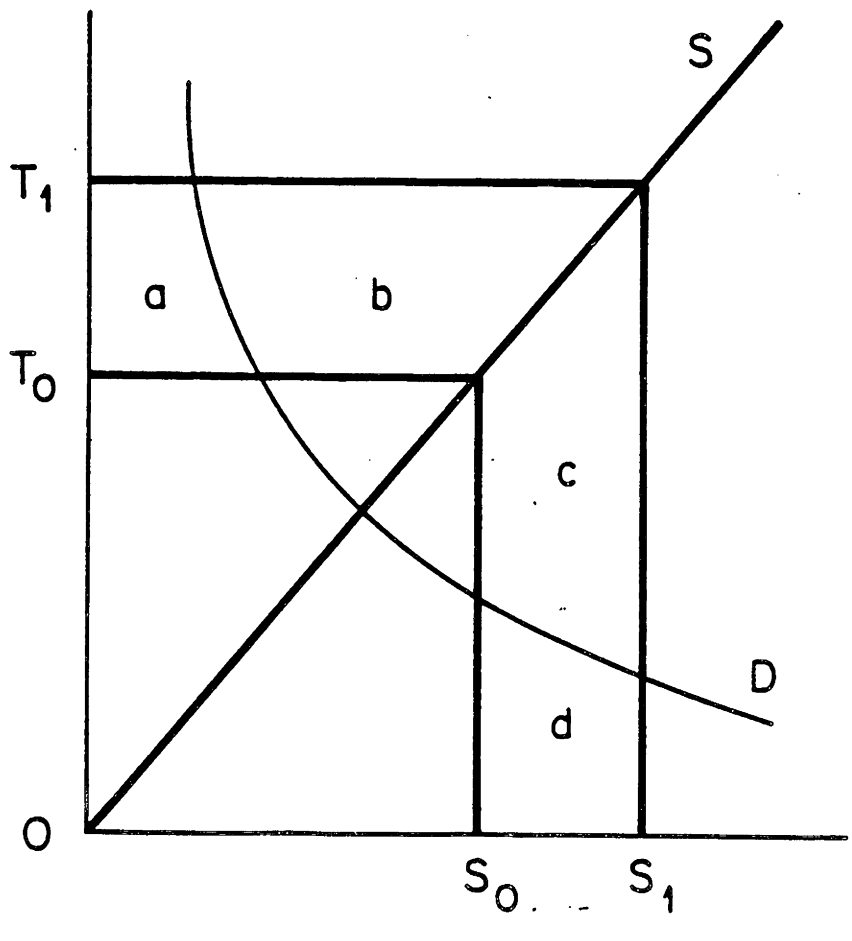
In the case of a perfectly inelastic demand curve, the condition $1/Z - 1 > \alpha$ is both sufficient and necessary for consumer preference of a coupled program transfer of an additional dollar to innovators. The intuition of the proposition can be illustrated in Figure 3. Consider the additional transfer of $T_1S_1 - T_0S_0$ dollars to all producers, which is area $a + b + c + d$ in Figure 3. This could be done in two ways: through a $[T_1S_1 - T_0S_0]/N$ transfer to each innovator (as well as to each noninnovator) under a decoupled, per-firm payment scheme or through an increase in the target price from T_0 to T_1. The target price increase would imply a total profit increase of area $a + b$ for all producers taken together and a profit increase of $\Pi_I(T_1) - \Pi_I(T_0)$ for each innovator. The condition $1/Z - 1 > \alpha$ is simply that which assures for a small increase from T_0 to T_1,

(8) $$\frac{1}{N}[T_1S_1 - T_0S_0] < \Pi_I(T_1) - \Pi_1(T_0).$$

If expression (8) holds, the consumer under coupled policies can accomplish a greater transfer to innovators and at the same time gain from an increase in consumption--area d--that would otherwise be foregone with a lump-sum transfer. Under a perfectly inelastic demand curve, however, area d disappears and the consumers/taxpayers lose by area $a + b + c + d$ under either transfer scheme. The criterion for choosing a target price over a lump-sum payment would not involve any consumption gains but collapse to a question of targeting to innovators the greatest proportion of the additional dollar expended. It is the possibility of the additional consumption of area d that makes the condition $1/Z - 1 > \alpha$ sufficient but not necessary; while an increase in the support price might transfer less to the innovator than a direct per-producer payment, it could still increase total consumption as well.

As it turns out, the condition $1/Z - 1 > \alpha$ is sufficient for the superiority to consumers/taxpayers of coupled policies.

FIGURE 3. CONSUMER GAINS FROM PER-UNIT-OUTPUT PAYMENTS.



PROPOSITION 2b: *If a transfer policy is necessary to overcome obstruction [i,.e., the condition in expression* (7) *holds] and the percentage gain in an innovator's level of production over the industry average is greater than the supply elasticity, then the coupled policy is optimal for consumers/taxpayers for all elasticities of supply and demand meeting these conditions.*

PROOF:

Define $\rho = Z\,(1-l)\cdot(\theta/Z)^{\frac{-(1-\beta)}{\alpha+\beta}}$ from expression (7), such that if a transfer is necessary to accomplish the technical advance, then $\rho > 1$. That the ratio of an innovator's production to average production is greater than the supply elasticity implies that $1/(1+\alpha) > Z$. After some algebraic manipulations, the superiority to consumers of coupled over decoupled payments, $R_c > R_d$, implies

(9) $$\rho > \frac{1/(1+\alpha) - Z\phi}{1/(1+\alpha) - Z},$$

where

$$\phi = \frac{1-\beta\rho^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}}}{1-\beta}.$$

If $\rho > 1$, then $\phi > 1$, and the right-hand side of expression (9) is certainly less than unity.

The expression (9) presents the necessary condition for the superiority of coupled relative to decoupled policies for breaking producer coalitions. We can reexpress this condition as

(10) $$\frac{1}{1+\alpha} - Z\cdot\left[\frac{\rho-\phi}{\rho-1}\right] \geq 0$$

where $\phi \geq 1$ for all $0 \leq \beta \leq 1$ and $\rho \geq 1$. Note that if $\beta = 0$, then $\phi = 1$ and the conditions in Proposition 2b are both necessary and sufficient for $R_c > R_d$. As β grows positive, the term $(\rho - \phi)/(\rho - 1)$ decreases below unity, implying a trade-off between $Z = \lambda + (1 - \lambda)\theta$ and the demand elasticity in assuring that the benefits are greater from a coupled transfer relative to a decoupled one. [One may also note that $\phi \leq \rho$ for all $\rho \geq 1$.]

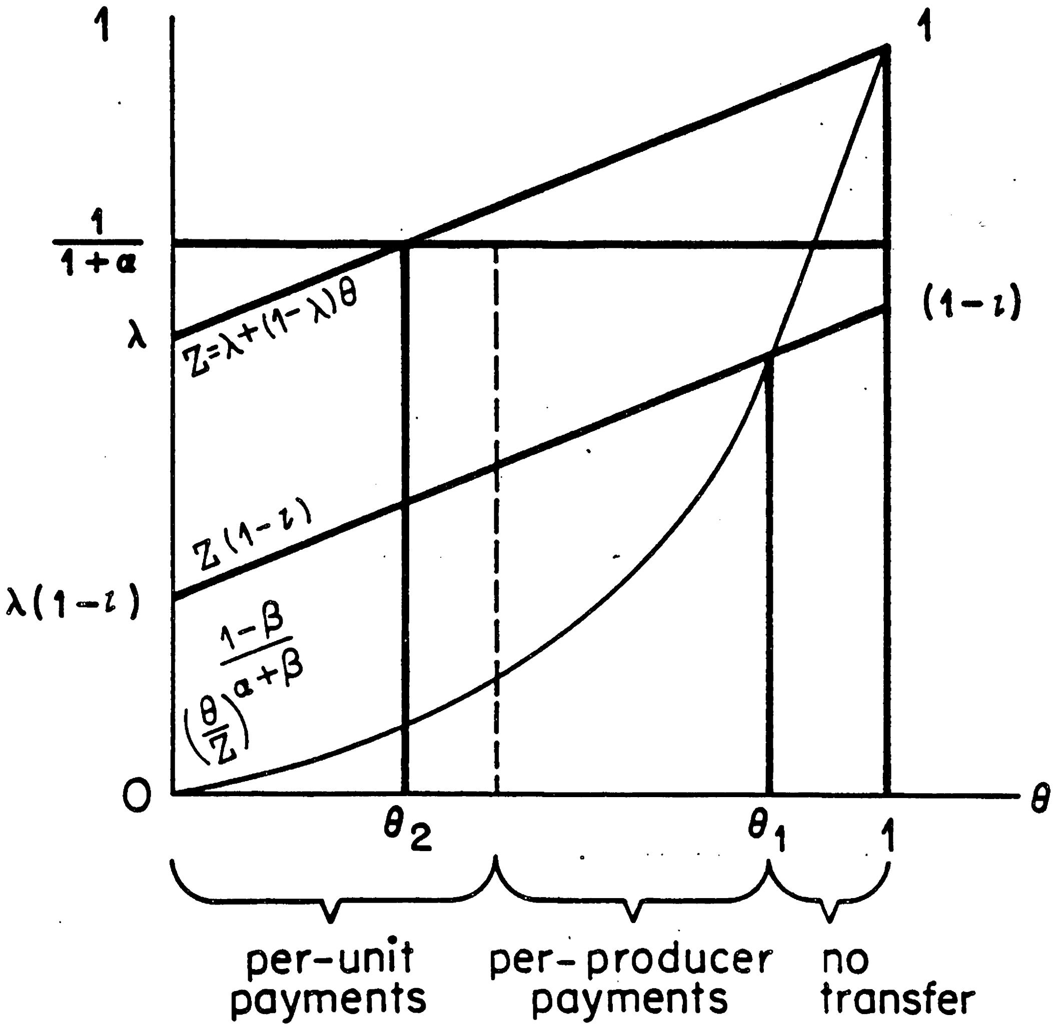
The choice of public policies can be characterized by Figure 4. The necessity of a transfer scheme is given by the inequality condition of expression (7). Let θ_1 be such that the equality in expression (7) strictly holds. For levels of θ above θ_1, producers are unwilling to form the coalition to obstruct the technical change, and a public policy would include only a pure PERT. [Given, that is, that the consumer benefits outweigh the cost of implementing the change which are nonexistent here.] Where $\theta \leq \theta_1$, some transfer mechanism is necessary to break a producer coalition against the change. Note that as $l \rightarrow 0$, $\theta_1 \rightarrow 1$, and as $l \rightarrow 1$, $\theta_1 \rightarrow 0$. Note also that, as demand becomes more elastic, that is, as β increases toward unity, θ_1 decreases (because the derivative of the right-hand side of expression (7) is positive).

The choice between policies is indicated by the inequality given by expression (10). Let θ_2 be such that $1/(1 + \alpha) = Z = \lambda + (1 - \lambda)\, \theta_2$. For $\theta < \theta_2$, and for some θ sufficiently near θ_2, a per-unit-output payment scheme is better for consumers/taxpayers. For θ, sufficiently greater than θ_2, the per-firm scheme is superior.

As α, the elasticity of supply, decreases, the critical value θ_2 increases toward unity; and indeed ϕ approaches unit also, implying that the "fuzzy" region above θ_2, where coupled policies are superior, vanishes. Note that for sufficiently high values of the proportion of innovators, λ, relative to the supply elasticity, $\lambda > 1/(1 + \alpha)$, then for no level of supply increase due to the technical change is a per-unit payment superior to a per-firm transfer.

FIGURE 4.

OPTIMAL TRANSFER SCHEME FOR LEVELS OF TECHNICAL ADVANCE



IV. Total Government Expenditures to Producers

The above discussions assume that consumers and taxpayers are the same group. In reality, however, a greater political weight may be put on outright expenditures to producers relative to consumer gains. There are, not surprisingly, conditions under which per-firm, lump-sum payments break producer coalitions more cheaply than per-unit-output payments and conditions under which the opposite is true. Given that a transfer scheme will take place, suppose the choice between coupled and decoupled policies is based solely on minimizing government expenditures. The following propositions characterize the optimal transfer scheme from a taxpayer's perspective.

PROPOSITION 3a: *Given that a transfer scheme is necessary, if the percentage gain in an innovator's production relative to the industry average is less than the supply elasticity, then the total transfer under the decoupled scheme is less than the total under the coupled scheme. That is, if* $1/Z - 1 < \alpha$*, the taxes paid out under the per-firm policy are less than the per-unit-output plan.*

PROOF:

Write $B_d - B_c$ as

$$B_d - B_c = P_0 S_0 \left(\frac{0}{Z}\right)^{\frac{1-\beta}{\alpha+\beta}} \cdot \left[\rho Z \left(1/(1-\alpha) - Z\right) - \left(1/(1+\alpha) - Z\rho^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}}\right)\right].$$

implying $B_d < B_c$ if

$$\rho > \frac{1/(1+\alpha) - Z\rho^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}}}{1/(1+\alpha) - Z}. \tag{11}$$

The left-hand side of expression (11) is greater than unity. The denominator of the right-hand side is negative when the percentage increase in an innovator's yield, relative to average yields, is less than the supply elasticity. The numerator is either positive or less in absolute value than the denominator, verifying that the inequality in expression (11) holds.

This proposition simply asserts a sufficient condition for tax outlays under decoupling to be less than those under per-unit payments. The intuition behind this proposition is similar to that concerning the superiority to consumers/taxpayers of coupled schemes when $1/Z - 1 > \alpha$. For high supply elasticities, the outlay for increased production from all firms under a targeted price tends to overwhelm any savings, relative to per-firm payments, that might arise by differentiating innovators and noninnovators. And similarly, as producers' output levels are less distinguishable--either because of a high proportion of innovators or a low level of technical change--the usefulness of narrowing payments through per-unit-output transfers grows less.

This proposition also provides some intuition regarding the "fuzzy" region above θ_2 in Figure 4. Where $\theta < \theta_2$, the unambiguous superiority for consumers/taxpayers of the coupled scheme results because it involves government expenditures that are near to, or lower than, the decoupled scheme; and, at the same time, it sufficiently increases the gross consumer surplus. Per-unit payments can target transfers more directly to innovators, and there is only a small accompanying output response. When innovators' output levels are near the average of all producers or when output response to support price is high, the greater expenditures under the per-unit scheme may outweigh any gain to consumers resulting from a lower market price.

On the other hand, if innovators' output levels are sufficiently greater than the industry average and the supply elasticity is sufficiently small, then the targeted price program involves less government expenditures than the decoupled program. This is the conclusion of the following proposition.

PROPOSITION 3b: *Given that a transfer scheme is necessary, the total transfer under the coupled scheme is less than the total transfer under the decoupled scheme, if the* *percentage gain in an innovator's yield over average yield is greater than the supply elasticity weighted by the inverse of the demand elasticity (i.e., if* $1/Z - 1 > \alpha/\beta$*).*

PROOF:

Given that $1/(1+\alpha) > Z$, $B_d - B_c \geq 0$ if

$$\rho \geq \frac{1/(1+\alpha) - Z\rho^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}}}{1/(1+a) - Z}. \tag{12}$$

Both the right-hand and left-hand sides of expression (12) are equal to unity when $\rho = 1$. The right-hand side increases at a decreasing rate as ρ increases. The strict inequality in (12) holds for $\rho > 1$ if the slope of the right-hand side at $\rho = 1$ is less than unity, which is the slope of the left-hand side. The derivative of the right-hand side with respect to ρ evaluated at $\rho = 1$ is

$$\frac{\frac{\alpha(1-\beta)}{\beta(1+\alpha)}}{\frac{1}{Z(1+\alpha)} - 1},$$

which is less than unity if

$$\frac{1}{Z} - 1 > \frac{\alpha}{\beta}.$$

The intuition here is that there is a trade-off between the increase in supply in response to the coupled policy and the ability of consumers to absorb the extra production. If the distinction between innovators and noninnovators is sufficiently great (i.e., a low Z) or, regardless of this distinction, the price effect of the per-unit payment is sufficiently small (i.e., a low α/β), then a coupled policy is less expensive to taxpayers. There is a region where the distinction between innovators' output levels and the industry average is of moderate size, $\alpha < 1/Z - 1 < \alpha/\beta$, where expenditures may be less for either transfer method. This region, however, vanishes as the supply elasticity vanishes (i.e., as $\alpha \to 0$).

V. A Model of Coalition Breaking with Uncertain Technical Change

The previous sections present a model where the level of technical advance is known prior to the implementation of the transfer scheme. The only element of imperfect knowledge is the inability of consumers/taxpayers to distinguish innovators from noninnovators, necessitating the use of generic transfer payments to break a potential obstructing coalition. This section introduces two elements of uncertainty to the level of technical change.

First, suppose that the aggregate level of technical advance is unknown at the time that a per-firm or per-unit payment program is announced. By aggregate technical advance, we mean the level of change in aggregate supply after dissemination of the future results of R&D. We assume that producers and consumers assign similar probabilities to possible levels of this aggregate change, that payments of whatever form are based on common expectations of future advances, and that they are not contingent on any particular outcome.

Second, suppose each producer is uncertain as to the degree to which he can take advantage of a future technical innovation. This individual uncertainty can arise either because the producer is uncertain of his own ability in the future (whether or not his own circumstances will change between today and tomorrow) or because the technical innovation itself may randomly favor some producer characteristics more than others and producers are heterogeneous in these characteristics. Although each producer does not know his eventual ability to use the technical advance, he does form an expectation of that ability; and with this expectation, and anticipating the aggregate supply shift, the producer forms an expectation of his losses (or gains) from the dissemination of the technical advance.

In the previous sections, a producer's ability to use the technical innovation is either complete or nonexistent. This section, on the other hand, allows for a range of producer abilities, from highly innovative firms to those who use the advance only minimally. Nevertheless, the key element remains that consumers/taxpayers do not know *a priori* the expected abilities of producers. By allowing a range of innovative abilities, the model can now handle a more realistic description of what it means to break a coalition that could obstruct technical change. In the previous sections, the coalition is broken by making innovators indifferent to the change, regardless of the size of the innovating group relative to noninnovators. This permits even those advances most damaging to the producer group as a whole. In this section, however, the coalition is broken by making at least indifferent to the change a fixed percentage of all producers so that, for instance, a coalition of 70 percent of producers is just sufficient to obstruct the change, but by making at least 31 percent indifferent to, or desirous of, the change the advance is obtained.

Again, consider the case of a constant-elasticity supply curve for each producer as in the previous sections. After dissemination of the technical advance, the i^{th} firm's supply curve rotates outward:

$$s_i = t a_i \left(\frac{P}{c} \right)^{\alpha} ,$$

where the value t is the aggregate level of change and a_i is the individual producer's ability to take advantage of the change. Both t and a_i are considered to be independent random variables prior to innovation dissemination and during the design of the transfer scheme. For convenience only, allow that the index representing each producer, the i s , be such that the expected ability associated with an index value is at least as great as the expected abilities associated with larger indices. That is, $\bar{a}_1 \geq \bar{a}_2 \geq \bar{a}_3 \geq, \ldots,$ where $E\,[a_i] = \bar{a}_i$; and a strict inequality holds for at least one pair of i and $i + 1$. In this way we may indicate that, if the c^{th} producer expects to be indifferent to the technical change, then at least c

number of producers are indifferent to, or desirous of, the change. [And, if $\bar{a}_c > \bar{a}_{c+1}$, then only c producers are at least indifferent, the remainder being harmed.]

Assume the number of producers, N, is sufficiently large so that deviations from individuals' expected abilities tend to cancel out, and aggregate supply shifts can be characterized by the variable t and the average of expected abilities. Furthermore, without loss of generality, we take the average ability over all producers to be equal to unity, implying that aggregate supply after the innovation is realized is simply represented as a function of t and P:

$$S = \sum_i t a_i \left(\frac{P}{c}\right)^{\alpha} = tN \left(\frac{P}{c}\right)^{\alpha},$$

where $\Sigma a_i = N$. Taking the demand curve to be the same constant-elasticity case as in the previous sections, equilibrium market price can be represented as a proportion of the market price without the technical change:

$$P_1 = (c^{\alpha} b/N)^{1/(\alpha+\beta)} \cdot t^{-1/(\alpha+\beta)} = P_0 t^{-1/(\alpha+\beta)}.$$

Profit for the i^{th} producer after dissemination of the innovation is also represented as a proportion of profit without the change:

$$\Pi_i = t a_i \frac{1}{1+\alpha} \frac{P_1^{1+\alpha}}{c^{\alpha}} = a_i t^{\frac{-(1-\beta)}{\alpha+\beta}} \Pi_0,$$

where, once again, all producers make the same level of profit, Π_0, prior to the change. Define for shorthand $m_d = t^{\frac{-(1-\beta)}{\alpha+\beta}}$.

[In terms of the previous, nonstochastic case, we could write, for innovators with ability a_1 and noninnovators with ability a_2, $1/\theta = ta_1$, and $ta_2 = 1$. This would imply $t = \lambda \cdot 1/\theta + (1-\lambda) = Z/\theta$, and $a_1 = 1/Z$ and $a_2 = \theta/Z$.]

Let c/N be the smallest percentage of producers that consumers/taxpayers must make at least indifferent to the technical advance in order to prevent its obstruction. First, we turn to the lump-sum scheme and the condition under which a transfer is necessary. The per-firm transfer payment must be just enough to make the c^{th} producer just indifferent to the change. That is, the announced transfer must be the fixed profit under the obstruction less the expectation of the profit with the change. The total transfer that consumers/taxpayers expect to bear is N times this amount:

$$B_d = N \cdot \Pi_0[(1-l) - \bar{a}_c \bar{m}_d].$$

The expected gross consumer surplus under the lump-sum transfer is

$$CS_d = \frac{bP_0^{1-\beta}}{1-\beta} \cdot [1 - \bar{m}_d].$$

Expected net consumer benefits under the decoupled policy are again defined as $R_d = CS_d - B_d$. We shall take $\bar{m}_d$ to be defined by the mean and variance of t:

$$\bar{m}_d = (\bar{t})^{\frac{-(1-\beta)}{\alpha+\beta}} \cdot \left[1 + \frac{1}{2}\frac{(1-\beta)(1+\alpha)}{\alpha+\beta} \cdot v\right] = (\bar{t})^{\frac{-(1-\beta)}{\alpha+\beta}} \cdot V_d,$$

where v represents the coefficient of variation of t. A transfer is necessary only if $B_d > 0$, or if

(13) $$\rho = \frac{(1-l)}{\bar{a}_c \bar{m}_d} > 1.$$

For the per-unit scheme, the targeted price T is chosen such that expected profit to the c^{th} firm is what it would be given the obstruction of the technical advance. Under the targeted price, profit remains a random variable, but the remaining randomness is due to producers' uncertain abilities to take advantage of the change. Price uncertainty is eliminated, unlike in the lump-sum case where price uncertainty remains. In the same manner as in the previous sections, we define the announced targeted price as a proportion of the initial equilibrium market price:

$$T = P_0\left[\frac{1-l}{\bar{t}\,\bar{a}_c}\right]^{1/(1+\alpha)}.$$

This draws out, once the innovation is disseminated, an aggregate supply of

$$S_t = t\left[\frac{1-l}{\bar{t}\,\bar{a}_c}\right]^{\alpha/(1+\alpha)} \cdot N\left(\frac{P_0}{c}\right)^{\alpha} = t\left[\frac{1-l}{\bar{t}\,\bar{a}_c}\right]^{\alpha/(1+\alpha)} \cdot S_0.$$

We can thus define the expected total revenue expended as $E[TS_T] = P_0S_0(1 - l)/\bar{a}_c$. The resulting market-clearing price under the price support is found in the same manner as the nonstochastic case:

$$P_t = P_0\left[\frac{1-l}{\bar{t}\,\bar{a}_c}\right]^{\frac{-\alpha}{\beta(1+\alpha)}} \cdot t^{-1/\beta}.$$

The expected market value of the quantity acquired at support price T is

$$E\,[P_tS_t] = P_0S_0 \cdot \left[\frac{1-l}{\bar{t}\,\bar{a}_c}\right]^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}} \cdot \bar{m}_t,$$

where

$$\bar{m}_t = \bar{t}^{-(1-\beta)/\beta} \cdot \left[1 + \frac{1}{2} \cdot \frac{(1-\beta)}{\beta^2} \cdot v\right] = \bar{t}^{-(1-\beta)/\beta}\,V_t.$$

Hence, expected total transfers under the per-unit payment program is represented as

$$B_t = TS_t - P_t S_t = P_0 S_0 \left[\frac{1-l}{\bar{a}_c} - \left[\frac{1-l}{t\,\bar{a}_c} \right]^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}} \cdot \bar{m}_t \right].$$

Expected gross consumer surplus is

$$CS_t = \frac{bP_0^{1-\beta}}{1-\beta} \cdot \left[1 - \left[\frac{1-l}{t\,\bar{a}_c} \right]^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}} \cdot \bar{m}_t \right].$$

Expected net consumer benefits under the coupled policy are again defined as $R_t = CS_t - B_t$.

We may now characterize the conditions under which consumers/taxpayers would prefer coupled to decoupled policies under uncertain rates of technical change. In the case of a fixed rate of change, the key factor in deciding the superiority of coupled payments is the degree of difference between an innovator's output level and the industry average. In the case of uncertainty, the key factor is similar: the degree of difference between the c^{th} producer's expected ability to take advantage of the innovation and the average of all producers' expected abilities. The case of uncertainty, however, adds a new argument against a coupled policy in terms of the open-ended treasury exposure to large unexpected supply increases due to the technical advance.

PROPOSITION 4: *Suppose a transfer policy is necessary to overcome obstruction [i.e., the condition in expression* (13) *holds]. If the percentage gain in the* c^{th} *producer's expected output over the industry average expected output is greater than the supply elasticity, that is, if* $\bar{a}_c - 1 > \alpha$ *and if the variance of aggregate technical change is small, in the sense that* $V_d \approx V_t$*, then the coupled policy is optimal for consumers/taxpayers.*

PROOF:

That the c^{th} producer's expected yield relative to average expected yield is greater than the supply elasticity implies that $1/(1+\alpha) > 1/\bar{a}_c$. After some algebraic manipulations, the superiority to consumers of coupled over decoupled payments, $R_t > R_d$, implies

$$(14) \qquad \rho > \frac{\frac{1}{1+\alpha} - \frac{1}{\bar{a}_c} \cdot \frac{1-\beta\Psi}{1-\beta}}{\frac{1}{1+\alpha} - \frac{1}{\bar{a}_c}},$$

where

$$(15) \qquad \Psi = [\rho \cdot V_d]^{\frac{-\alpha(1-\beta)}{\beta(1+\alpha)}} \cdot \frac{V_t}{V_d}.$$

The left-hand side of the above expression is greater than unity if a transfer is necessary. In order to show the right-side of expression (14) is less than unity, we must show $(1-\beta\Psi)/(1-\beta) > 1$, or we must show $\Psi < 1$. Note that, since the value V_d is greater than unity, the bracketed term in expression (15) is less than unity. Therefore, given that $V_d \approx V_t$ (or their difference is sufficiently small), then $\Psi < 1$ and the proposition is proved.

The intuition behind Proposition 4 is very much like that behind the propositions in the previous sections. The difference between producers' expected abilities is reflected in the relative difference between the expected output levels of the most likely innovative and the average expected output levels over all firms. If it is not expected that producers' abilities will be distinguishable, then the usefulness of narrowing payments through per-unit payments is little. Again, as in the nonstochastic case, distortionary support prices serve a purpose to consumers/taxpayers by targeting those most likely to take full advantage of the technical change.

The proposition relies on a sufficiently accurate assessment of the aggregate rate of supply increase due to the technical advance. That is, the variance of the rate of change is small relative to the expected value. A sufficiently small v implies that $V_d = V_t$, where the "sufficiency" of v depends on the elasticities of supply and demand. [Indeed, one can show that, for all $v > 0$ and $0 < \beta < 1$, it is true that $V_t > V_d$.]

The sensitivity of the truth of the proposition to the variance of technical change highlights a potential failure, or trap, associated with coupled payments. Per-firm, lump-sum payments are fixed; and although, if the technical advance is small, consumers could end up paying for nonexistent output increases, there is a limit on treasury outlays, regardless of how great the technical advance. The per-unit, coupled scheme, on the other hand, does not lock in a level of transfers. If the technical advance turns out to be small, then outlays will also be small; but if the technical advance should turn out to be very large, then the treasury is exposed to similarly large outlays. In other words, decoupled payments would tend to be unnecessarily large for small realized rates of change but would offer consumers/taxpayers a windfall if the change was unexpectedly large. Coupled payments would tend to be small for small rates of change, yielding only small windfall benefits to consumers (if any), but would tend to be unnecessarily large for unexpectedly large changes.

The important aspect that causes such a potential drawback for the coupled policy, as it is presented here, is that the targeted price T is not contingent on the level of technical change. If the future rate of technical change were known (i.e., if $v = 0$), the level of support, necessary to maintain the indifference of the c^{th} producer to the change, would vary inversely with the level of t. For while the promised targeted price may increase relative to the market-clearing price as t increases, the market-clearing price falls; and so the support price also falls relative to the initial equilibrium.

VI. Conclusion

Analyzing wealth transfers in isolation does not reveal the motivating and underlying political-economic relations that exist between social groups. Taxes and subsidies are a part of larger portfolio of policies, all of which have some effect on the distribution of welfare. In the context of other policies, wealth transfers may serve a remunerative function, and recipients as a group may actually be losers when one accounts for implementation of the larger portfolio. Furthermore, the particular means of redistribution may serve a purpose beyond that of simply transferring wealth. In particular, nonneutral payments, going disproportionately to losers who can take some advantage of other surplus-increasing policies, may provide a less expensive means of preempting coalitions that would otherwise obstruct the entire portfolio.

In the model presented here, a wasteful transfer, one coupled to the level of firm output, is useful to consumers/taxpayers because it effectively differentiates between decentralized producers; thus, it more cheaply counters the political opposition to a supply enhancement by dividing and conquering. This is in contrast to other models of political competition between groups which suggest that the transfer mechanism would tend to be the most efficient, in the sense of minimizing deadweight loss (Becker, 1983; Bruce L. Gardner, 1983), because all groups could share in an efficiency gain. Our analysis allows the governing group, consumers/taxpayers, to overcome the problem of imperfect information (about who is an innovator) through its choice of the redistribution scheme; therefore, reducing inefficiency is not coincidental to the interests of at least one group. Similarly, one can subject public choice of the method of taxation to the same analysis.

The PERT/PEST analytical framework is particularly relevant to the current debate over reform of agricultural policies. Many economists approach this topic assuming that wealth transfers are the inefficient outcomes of chaotic rent seeking. Their recommendations to achieve reform are based on the belief that wasteful farm subsidies are the rewards of raw political power, or the consequence of consumer ignorance, and that a knowledgeable public would be concerned with gaining inefficiency, if not with eliminating transfers altogether. Our framework, on the other hand, explains how a seemingly inefficient policy that appears to harm consumers could be in reality a rational component of a larger portfolio of policies ultimately benefiting consumers at the expense of producers.

It does not follow that the level of wealth transfer is in consumers' immediate best interests. Indeed, if the technological advance in our model is a unique event, then, once it occurred, consumers as taxpayers would renege on their promise of redistribution. Technological advances, however, are ongoing, and the ability of consumers to secure future acquiescence of continued supply expansion depends on their past fidelity. (The on-going apparent political power of producers may arise, therefore, from the repeated nature of the technological game.) Moreover, due to random shocks, including those to the rate of technological change, realized transfers may be unnecessarily large under coupled policies. Future questions to examine, therefore, pertain to a coupled scheme where the targeted price is contingent on an as-yet-unknown rate of technological change.

FOOTNOTES

[1]There are several discussions in the agricultural economics literature regarding the implications of various types of supply shifts on producer welfare. See, for examples, R. K. Lindner and F. G. Jarrett (1978); George W. Norton and Jeffrey S. Davis (1981); and Gay Y. Miller, Joseph M. Rosenblatt, and Leroy J. Husak (1988). Here we purposely make use of a supply shift that guarantees that producers will be harmed given an inelastic demand curve; if some benign shift occurs (because costs fall by more than revenue in equilibrium), then the question of associated transfers would be moot.

[2]We put aside the question of what social and economic mechanisms actually determine the particular nature of the technological advance, whether it is laborsaving, land-saving, etc. Induced-innovation theory (e.g., Hans Binswanger and Vernon W. Ruttan, 1978), with its emphasis on the search for microeconomic efficiency, may explain in part the type of technological innovations that might become available for dissemination and adoption. Although induced-innovation theory recognizes the connection between institutions and technical change, application of the theory tends to overlook the influence of political competition between groups. We are inclined to concur with Alain de Janvry and E. Phillip LeVeen (1983) who note (p. 25), ". . . that the theories of technological change that have been proposed to explain the U. S. experience have generally fallen into excessively 'economistic' arguments. Technical change must be understood not only as a quest for higher economic efficiency, but also as an instrument of change (or of resistance to change) in social relations. Hence the determinants of technical change must be sought in *both* the response to new economic conditions *and* in the struggle for the definition of social relations. The state is an essential institution through which these objective (economic) and subjective (social) forces are translated into new technologies. Any theory of technical change must incorporate a theory of the state and of how it responds through technology and other policies to both economic and political pressures."

[3]In our discussion we exclude the possibility of a counter-bribe by noninnovators to keep innovators in the obstructing coalition. Transfers to noninnovators, in the form of generic payments, may preclude rational transfers from that group to innovators. To see this, in Figure 2 allow area $e \neq$ area b and area $d \neq$ area a. Permitting a counter-offer by noninnovators, a lump-sum payment scheme that breaks the coalition must be chosen such that innovators gain relative to the status quo by more than noninnovators lose; that is, the decoupled transfer $(b + c)$ must be set such that $(b + c + d) - (a + b + c) \geq a$, or $d \geq 2a$. Similarly, a coupled transfer that breaks the coalition must satisfy the condition $(c + d + e) - (a + b + c) \geq (a + b)$, or $(d + e) \geq 2(a + b)$.

Under the conditions of perfectly inelastic supply curves, and initially identical producers, consumers can always find a coupled policy that is not dominated by a decoupled policy. To see this, take a decoupled payment scheme such that $d - 2a = \varepsilon > 0$. Consumers prefer a coupled payment of $(c + e)$ to innovators and c to noninnovators, if $(c + e) + c \leq 2(b + c)$, or if $e \leq 2b$. Setting the targeted price such that $e = (2b - \varepsilon/2)$ gives one coupled scheme that consumers prefer over the decoupled scheme.

These remarks suggest that we may be able to relax the assumption of complete ignorance on the part of consumers/taxpayers as to who is an innovator and who is not. Generic policies may thus serve a strategic function apart from being a response to limited information. A generic payment scheme both makes indifferent some producers to the combination of policies and eliminates the incentive of losing producers to invest time and effort in maintaining an obstructing coalition.

[4]One could take the proportion λ as the initial proportion of total supply produced by an innovator. In this case the lump-sum scheme would entail payments based on this initial production level.

REFERENCES

Becker, Gary S., "A Theory of Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics*, August 1983, *98*, 371-400.

Binswanger, Hans P. and Ruttan, Vernon W., *Induced Innovation: Technology, Institutions, and Development*, Baltimore: The Johns Hopkins University Press, 1978.

de Janvry, Alain and LeVeen, E. Phillip, "Aspects of the Political Economy of Technical Change in Developed Economies," in Martin Pineiro and Eduardo Trigo, eds., *Technical Change and Social Conflict in Agriculture*, Boulder: Westview Press, 1983.

Downs, A., *An Economic Theory of Democracy*, New York: Harper, 1957.

Evenson, Robert E., Waggoner, Paul F. and Ruttan, Vernon W., "Economic Benefits from Research: An Example from Agriculture," *Science*, September 1979, *205*, 1101-07.

Gardner, Bruce L., "Efficient Redistribution Through Commodity Markets," *American Journal of Agricultural Economics*, May 1983, *65*, 225-34.

Krueger, A., "The Political Economy of the Rent-Seeking Society," *American Economic Review*, June 1974, *64*, 291-303.

Lindner, R. K. and F. G. Jarrett, "Supply Shifts and the Size of Research Benefits," *American Journal of Agricultural Economics*, February 1978, *60*, 48-59.

Miller, Gay Y., Joseph M. Rosenblatt and Leroy J. Husak, "The Effects of Supply Shifts on Producer Surplus," *American Journal of Agricultural Economics*, November 1988, *70*, 886-91.

Norton, George W. and Jeffrey S. Davis, "Evaluating Returns to Agricultural Research: A Review," *American Journal of Agricultural Economics*, November 1981, *63*, 685-99.

Olson, M., Jr., *The Logic of Collective Action*, Cambridge, Massachusetts: Harvard University Press, 1965.

Peltzman, Sam, "Toward a More General Theory of Regulation," *Journal of Law and Economics*, August 1976, *19*, 211-40.

Rausser, Gordon C., "Political Economic Markets: PERTs and PESTs in Food and Agriculture," *American Journal of Agricultural Economics*, December 1982, *64*, 821-33.

Ruttan, Vernon W., *Agricultural Research Policy*, Minneapolis: University of Minnesota Press, 1982.

Stigler, George J., "The Theory of Economic Regulation," *Bell Journal of Economics*, 1971, *2*, 3-21.

Tullock, Gordon C., "The Welfare Costs of Tariffs, Monopolies, and Theft," *Western Economics Journal*, 1967, *5*, 224-32.