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Authors
Rausser, Gordon C.
Foster, William E.

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PUBLIC GOODS AND WEALTH TRANSFER TRADEOFFS

by

Gordon C. Rausser*

and

William E. Foster**

*Robert Gordon Sproul Distinguished Professor, Department of Agricultural and Resource Economics, University of California at Berkeley.

**Assistant Professor, Department of Economics and Business, North Carolina State University, Raleigh.

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PUBLIC GOODS AND WEALTH TRANSFER TRADEOFFS

1. Introduction

Governments use many forms of subsidies and taxes to transfer wealth between economic groups, in particular between agricultural producers, and consumers and taxpayers. Most interventions are nonneutral with respect to production, altering price signals facing firms, and distorting market prices; a few are relative neutral, approximating lump-sum payments, and leaving output and input prices only mildly affected. From a standpoint of economic efficiency, distorting (or coupled) policies are widely criticized, and nondistorting (or decoupled) policies wildly supported. Nevertheless the reliance by governments on distorting interventions is commonplace and largely impervious to reform. In order to understand both governmental intervention in agricultural markets and the constraints to policy reforms, political economic analysis must address two questions. The first regards the preference of distorting over nondistorting policies. The second regards the choice of the particular form of distorting policy; that is, the choice of the specific output or input markets that will carry the distorting taxes or subsidies.

In this chapter, we generalize the results of the previous chapter by examining the role of output subsidies, input subsidies, or lump-sum transfers in agricultural markets. In the analysis, consumers and taxpayers have an incentive to target a certain level of wealth transfer to a specific and *a priori* unobserved set of producers within a broadly subsidized sector. For generic transfers, distorting policies may achieve the targeted transfer at least cost. One implication of the results is that reform of distorting market interventions may be more difficult than widely believed, because apparent losers -- consumers and taxpayers -- may actually prefer nonneutral transfers to producers. Targeting wealth transfers to a particular producer group, as opposed to the entire industry, is the key to explaining the preference for distorting payments over lump-sum payments. The analytical subsidization framework is related to the optimal taxation and least-cost-subsidization literature (e.g., Mirrlees [1976], Chambers [1985]).

Section 2 presents a conceptual model of wealth transfers from consumers and taxpayers to producers in the presence of other productive policies that increase potential total social welfare (Rausser [1991]). Of the class of generic payments (per-capita or per-unit output), nonneutral payments are the most effective mechanism for overcoming a potential producer coalition which opposes moves from the status quo. The third section presents the optimal selection by consumers/taxpayers of the output and input subsidization levels as well as the level of per-capita (lump-sum) payments. The preference over subsidy mechanisms depends on the ability of nontargeted groups to take advantage of the mechanism and on the social costs of the associated market distortions. The analysis determines under what conditions input subsidies or output subsidies are likely to be observed. The concluding section discusses the implications of our results to the broader issue of policy reform.

2. A Portfolio of Policies: Supply-Expansion and Wealth Transfers

The motives behind the choice of distorting transfers over nondistorting transfers are not fully appreciated. Indeed, faced with the seeming omnipresence of distorting policies, many political economic analyses of governmental intervention tend to dismiss altogether neutral policies as impractical and to ignore the fundamental question of why states opt for socially wasteful transfers. The analytical concentration on the selection of the level of transfers between groups, to the neglect of the choice of the level of distortion, is due to conventional rent-seeking approaches to explaining production subsidies. These frameworks focus on the relative organization power of groups receiving or granting wealth transfers (e.g., Stigler [1971], Peltzman [1976], Becker [1983]). An important element of these frameworks is that groups struggle over a limited amount of potential total wealth, or surplus. The greatest level of wealth available to all parties together is defined by the ideal of freely operating markets, where no rent seeking takes place and where, of course, subsidies and taxes

necessarily waste some of this potential.

In such models, wealth transfers do not serve the public interest; they are only the rewards of political maneuver, pork barrel, and the consumer's (and taxpayer's) unwillingness or inability to resist interventions. Two corollaries are notable. First, the degree to which groups gain directly from these transfers is a measure of their political clout. Second, transfer mechanisms would tend to be the most efficient, or least distorting, in the sense of minimizing deadweight losses, because all groups could share in an efficiency gain (e.g., Becker [1983], Gardner [1987]). The willful choice of a more socially wasteful transfer method over a less wasteful method cannot be inferred from this model. Such selections can only be generated by reference to additional assumptions regarding the characteristics of transfer methods. For example, in a world of limited information, distorting policies may be less transparent, concealing the level of transfers, and thus serve to circumvent political opposition (Magee, Brock, and Young [1989]).

An alternative view of wealth transfers holds that policies that increase total social welfare may have to be accompanied by subsidies, or they will not be implemented because of obstruction by potentially losing groups (Rausser [1991]). 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 a new policy. Distorting wealth transfers, compared to neutral transfers, may actually serve the purpose of overcoming this veto more efficiently by targeting members of the losing coalition who suffer less. These members who suffer less are able to take advantage of the new policy to some degree. In effect, the taxed group is in control of the policy choices, including the method of wealth transfer, and the subsidized group merely sets constraints on the feasible choices. This 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.

Unproductive wealth transfers do not exist in isolation from a larger set of government activities, some expanding total social welfare and others promoting waste. 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 effects on the distribution of society's economic surplus; and (2) those which are meant to redistribute wealth between groups, and are ostensibly independent of the question of strictly economic efficiency (Rausser [1982], Mueller [1989]). The distinction between the two types of policies is briefly summarized by the popular metaphor of the economy as pie: the first type of policy expands the size of the pie, and the second type allocates the portions served to various groups.

The expansion of the social-welfare pie does not guarantee that each group'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. For example, a group that gains from the investment in public goods may promote transfers to groups that suffer from the investment, so that these groups receiving the transfer will acquiesce to the public good. The wealth transfer 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 investment, the transfer is a crucial and Pareto-improving component of general policy. An important point that follows from this model is that the true social costs of any policy cannot be measured in isolation. The benefit of a wasteful policy may lie in the public good which it allows to exist; and the benefit of investment in a public good may be less than those observed directly, carrying with it inefficient transfer schemes necessary to assure its political viability.

Wealth transfers to a large group, such as agricultural producers, are typically shared unequally by firms; and it is in consumers' and taxpayers' intertests that this be so. In the context of a supply-enhancing public good (such as technological research and development), some producers are harmed less than the industry average because they can take greater advantage of the advance. Wealth transfers weighted in favor of these *innovators* would serve to break producer coalitions obstructing change with less expense to consumers and taxpayers. Those who expand production or cut costs to a greater degree simply need less transfer payments to be made indifferent to the investment in the public good. Non-neutral policies target payments according to either production levels or input use. Therefore, a transfer based on production which makes those innovators expanding their output just as well off as without the advance, would transfer less to those who take less advantage of the public good. A transfer based on the use of an input encouraged by use of the public good will have a similar effect. The popularity of nonneutral (i.e., coupled) payments in agriculture especially may be explained by this property of targeting transfers from consumers to innovators, that is, to those firms less harmed by investments in public goods and, thus, to those most cheaply divided from a coalition that might obstruct moves from the status quo.

3. A Model of Optimal Subsidies to Targeted Producers

The optimal subsidy rule is formalized here for consumers/taxpayers desiring to target a specific subset of firms, and thus prevent potential coalitions that may block change. Consider two interest groups in society -- consumers/taxpayers and producers in an industry. Members of these groups behave competitively in the marketplace but may form coalitions with other group members in the political arena. Each group is composed of many members, and there is some rule for weighting the votes of individual members to decide each group's position on a particular policy. Producers are endowed with different levels of ability to take advantage of a public-interest policy. In this setting, ability may differ by location, vintage of capital, endowments of human

capital, and so forth. We measure the welfare of each of N producers by the level of rent or profit to their ownership of a scarce resource, which is a function of output price, p, and input prices, w. We measure consumer welfare by the Marshallian surplus associated with consumption of aggregate output, and taxpayer welfare by the total outlays associated with all price subsidies and lump-sum payments. The particular public-interest policy may be, for example, the release of a technical innovation that will increase production but, by doing so, will also harm enough producers by decreasing output price that a coalition will form to block the release.

To formalize the concept of ability to take advantage of the public good, let a_i be an index of the ith firm's attributes. Define $\pi_0(a_i)$ as the rent accruing to the ith firm prior to the implementation of the public good policy; and $\pi_i = \pi(p, w, a_i)$ as the rent accruing with the release under output price, p, and input prices, w. We assume that producers own the fixed factors and that all other inputs are free to move across industries with perfectly elastic supplies facing the industry in question. Define ability to take advantage of the public good as an ranking of firms, $i = 1, 2, ..., N$, such that

$$\pi_0(a_i) - \pi(p, w, a_i) \le \pi_0(a_j) - \pi(p, w, a_j) \qquad (1)$$

for all $i \le j$, and for p and w in reasonable ranges. Intuitively, condition (1) implies that firms of higher level ability gain relatively more, or lose relatively less, from the public good. In this way we may indicate that, if the cth producer expects to be indifferent to the public good policy, then at least c number of producers are indifferent to, or desirous of, the new policy. And if $a_c > a_{c+1}$ then only the first c producers are at least indifferent, the remainder being harmed.

Define V as the minimum number of producer votes needed to have the producer group support the innovation release. Under a weighted-vote rule, $w(i)$, define the index c such that

$$V = \sum_{1}^{c} w(i), \qquad (2)$$

where the weighting rule could be based on the initial level of output. Therefore, any generic compensation scheme that affects the producer output or input prices, or offers a per-producer, price-neutral payment need only make indifferent the cth producer in order to gain the producer group's acquiescence to the policy.

The individual production levels and input demands are found by Hotelling's lemma:

$$y_i = \frac{\partial \pi_i}{\partial p} \text{ , and } x_{ki} = \frac{\partial \pi_i}{\partial w_k} \text{ , } k = 1, K \text{ .} \tag{3}$$

Aggregate supply, S, and aggregate or total input utilization is simply the sum of the N individual firms' behavior:

$$S = \sum y_i \text{ , and } X_k = \sum x_{ki} \text{ , } i = 1, K \text{ .} \tag{4}$$

In what follows, we will be making use of the following notation. The percent deviation of the cth producer's production level, y_c, from the industry's average, $\bar{y}$, is represented by

$$\rho_0 = y_c / \bar{y} - 1 \text{ ,} \tag{5a}$$

and the percent deviation of the cth producers input use, x_{kc}, from the industry's average, $\bar{x}_k$, is represented by

$$\rho_k = x_{kc} / \bar{x}_k - 1 \text{ , } i = 1, K \text{ .} \tag{5b}$$

Suppose that a blocking coalition of producers would obstruct the implementation of the public good without some form of compensation, but that the coalition is avoided by making at least indifferent to the change a fixed percentage of all producers. Let c index the smallest percentage of producers that consumers/taxpayers, acting as the government, must make at least indifferent to the change in order to prevent its obstruction. Of course, for some public goods the cth producer may by better off than prior to the change: $\pi(p_0, w_0) \leq \pi(p_1, w_1; a_c)$, implying that no wealth transfers are necessary to obtain the policy. But for other public goods, some set of per unit output and

input price subsidies, s and d, and lump-sum payments, r, are required to break the coalition. The consumer/taxpayer will choose a set (s, d, r) such that the cth producer is just indifferent to the change. Representing producer output prices by $\hat{p} = p + s$, and input prices by $\hat{w}_i = w_i - d_i$, the consumer/taxpayer is constrained to set

$$\pi_0 = \pi(\hat{p}, \hat{w}; a_c) + r , \tag{6}$$

where π_0 is the cth producer's pre-public-good level of welfare.

We represent the subsidy rates on prices as $\sigma = s/(p + s)$ and $\delta_i = d_i/(w_i - d_i)$. The consumer/taxpayer's problem is to select the various subsidy levels in order to target the cth producer in the most efficient manner. We must recognize that prices may be altered by the subsidies, because all producers respond to changes in prices, expanding supply or changing input demand with increases in s and d. We take output price, p, to be endogenous and input supplies facing the industry to be perfectly elastic.[1] Market output price will equilibrate aggregate supply and demand:

$$S(p + s, w - d) = D(p) . \tag{7}$$

For ease of exposition, we represent the response of output prices to the subsidy as

$$\frac{\partial p}{\partial s} = -\frac{\partial S}{\partial p} / (\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p}) = -\frac{\varepsilon_p}{[\varepsilon_p + \gamma(1 - \sigma)^{-1}]} . \tag{8}$$

where ε_p is the elasticity of aggregate suply with respect to output price and γ is the absolute value of the demand elasticity. Similarly,

$$\frac{\partial p}{\partial d_i} = \frac{\partial S}{\partial w_i} / (\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p}) = -\frac{\partial X_i}{\partial p} / (\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p}) = -(X_i/S)(-\eta_{ip})/[\varepsilon_p + \gamma(1 - \sigma)] ; \tag{9}$$

where η_{ip} is the elasticity of total input utilization with respect to output price.

Total government outlays, G, are given by

$$G = sS + \sum d_i X_i + N[\pi_0 - \pi(\hat{p}, \hat{w}; a_c)] ; \tag{10}$$

where $sS + \sum d_i X_i$ represents the level of distorting payments due to output and input subsidies, and $N[\pi_0 - \pi_c]$ represents the level of per-capita payments. The consumer surplus, CS, is measured by the area under the demand curve for the output:

$$CS = \int_p^{\infty} D(z)\,dz \ . \tag{11}$$

The use of both output and input subsidies are redundant, if all prices can be subsidized. This is because subsidizing via the output market is equivalent to equiproportional input subsidies (Chambers [1985]). Typically, however, governments do not have access to all input markets in order to affect prices. Indeed, governments tend to concentrate their subsidization efforts in one or two markets, usually in the output market.[2] We first turn our attention to such subsidy schemes.

3.1 Output Subsidies

With only an output subsidy and lump-sum payments, the optimal levels of s and r are found by maximizing the consumer/taxpayer's criterion function given by

$$\max_s \ W = \int_p^{\infty} D(z)\,dz - sS(p + s, w) - N[\pi_0 - \pi(\hat{p}, w; a_c)] \ . \tag{12}$$

The optimal level of s is given by the first order condition

$$\frac{\partial W}{\partial s} = -D(p)\frac{\partial p}{\partial s} - S - s\frac{\partial S}{\partial p}(\frac{\partial p}{\partial s} + 1) + Ny_c(\frac{\partial p}{\partial s} + 1) = 0 \ . \tag{13}$$

Defining the industry's average production by $\bar{y} = D/N$, we can solve (13) for the optimal subsidy level as

$$\frac{s}{p + s}\frac{\partial S}{\partial p}\frac{p + s}{S} = \frac{y_c}{\bar{y}} - 1 \ , \text{ or} \tag{14a}$$

$$\sigma = \frac{\rho_0}{\varepsilon_p} \ . \tag{14b}$$

This result demonstrates

Proposition 1: The optimal rate of distortion in the output market is equal to the percent deviation of the targeted producer's output from the industry's average weighted by the reciprocal of the supply elasticity.

Intuitively, the value ρ_0 measures the output of the targeted producer relative to the industry's average, and thus it measures the distinguishability of the cth producer. *Ceteris paribus,* the greater the targeted producer's new output relative to the industry's average -- that is, the easier it is to identify the targeted firm by its output -- the greater will the government rely on nonneutral payments, and the greater the optimal rate of distortion. In contrast, the greater the price responsiveness of supply to increases in the subsidy rate, the less the government would rely on coupled payments, and the more on per-firm, neutral payments.

Expression (14b) illustrates that the use of distorting subsidies takes advantage of the heterogeneity of the public good effect on producers, with some producers being able to expand output more easily than others. This expression also shows the trade-off between identifying the targeted producer via an output subsidy and the inefficiency in production created by distorting prices.

The gain to consumers, due to the consumer-price decrease as producers expand output in response to the subsidy, makes the coupled scheme relatively more attractive than the per-firm scheme. The taxpayer interest alone may prefer coupled transfers, although the subsidy rate will typically be less. To see this, suppose there is a differential weight on consumer welfare as opposed to tax outlays. That is, let the consumer/taxpayer welfare be given by $W = (1 - \lambda)CS + G$. The rule for optimal tax subsidy may now be expressed as

$$\frac{\partial W}{\partial s} = (1 - \lambda)D(p)\frac{\partial p}{\partial s} - S - s\frac{\partial S}{\partial p}(\frac{\partial p}{\partial s} + 1) + Ny_c(\frac{\partial p}{\partial s} + 1) = 0. \tag{15}$$

This yields

Proposition 2: The simple rule for optimal rate of price distortion is given by

$$\sigma = \frac{\rho_0}{\varepsilon_p} - \frac{\lambda}{\gamma} , \tag{16}$$

where the value of λ represents the weight on expenditures relative to that on consumer surplus, and γ represents the absolute value of the demand elasticity.

As the weight on expenditures increases the subsidy rate decreases, and there is a greater reliance on lump-sum payments. Even if the government places all weight outlays, however, and zero on consumer surplus, there is still an incentive to have a positive subsidy rate, a distorting policy, if $\rho_0 > \varepsilon_p/\gamma$. 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 the targeted firm's output and the industry's average is sufficiently great (i.e., a high ρ_0), or, regardless of the distinction, if the price effect of the coupled payment is sufficiently small (i.e., a low ε_p/γ), then a coupled policy is less expensive to taxpayers.

Coupled payments are worthless at distinguishing between producers when the producer being targeted is simply the representative firm. When producers are homogeneous in their response to change, there is little economic incentive for coupled transfers. Coupled, distorting payments are preferred when producers are likely to respond at different rates to change. If government represents only consumers and taxpayer interests and all producers immediately adopted some technical advance, or could make use of some other public good, then remunerative policies will be nondistorting. When some producers adopt or adopt more quickly than others, and some perhaps not at all, then distorting payments are optimal.

3.2 Input Subsidies

With only a single input subsidy, say on the first indexed input, X_1, the level of the subsidy is found by maximizing the consumer/taxpayer's criterion function given by

$$\max_{d_1} W = \int_p^\infty D(z)dz - d_1 X_1 - N[\pi_0 - \pi(p, \hat{w}; a_c)] . \tag{17}$$

The optimal level of the input subsidy is given by

$$\frac{\partial W}{\partial d_1} = -D(p)\frac{\partial p}{\partial d_1} - X_1 - d_1\frac{\partial X_1}{\partial p}\frac{\partial p}{\partial d_1} + d_1\frac{\partial X_1}{\partial w_1} + Ny_c\frac{\partial p}{\partial d_1} + Nx_{1c} = 0 , \tag{18}$$

implying

$$X_1\rho_1 + S\frac{\partial p}{\partial d_1}\rho_0 - d_1\frac{\partial X_1}{\partial p}\frac{\partial p}{\partial d_1} + d_1\frac{\partial X_1}{\partial w_1} = 0 . \tag{19}$$

Hence,

Proposition 3: The optimal subsidy rate on a single input, δ_1, depends on the relative use by the targeted firm of the input, as well as the relative output level:

$$\rho_1 - \frac{\eta_{1p}}{\varepsilon_p + \gamma}(\rho_0 + \delta_1\varepsilon_1) + \delta_1\eta_{11} = 0 , \tag{20}$$

where $\varepsilon_1 = (\partial S/\partial w_1)\cdot(w_1 - d_1)/S$, the elasticity of supply with respect to a change in the price of the first input, and where $\eta_{ij} = (\partial X_i/\partial w_j)\cdot(w_j - d_j)/X_j$, the cross-elasticity of demand for the ith input with respect to a change in the jth input price.

Expression (20) can be re-written in terms of the price distortion:

$$\delta_1 = [\frac{\rho_1}{\eta_{1p}} - \frac{\rho_0}{\varepsilon_p + \gamma}]\cdot[\frac{\varepsilon_1}{\varepsilon_p + \gamma} - \frac{\eta_{11}}{\eta_{1p}}]^{-1} . \tag{21}$$

Assuming that the second-order condition holds for maximization, the denominator of (21) is positive. Again as in the output subsidy case, there is a trade-off between distinguishing the innovator via coupled payments and the social costs of distorting subsidies. *Ceteris paribus,* as the innovator uses more of an input relative to the industry's average use of that input, it is in the consumer/taxpayer's interest to rely more heavily on the input price rather than per-firm payments in order to accomplish the targeted payments. Note that a positive input subsidy rate will not hold for all targeted producers, as it does in the case of an output subsidy. The input subsidy is positive if and only if $\rho_1/\eta_{1p} > (\rho_0/\varepsilon_p + \gamma)$. The intuition is that the input subsidy drives output price

down, harming all producers; and innovators, by producing a greater output, are harmed disproportionately by the output price fall. The greater the relative output of the innovator the smaller the input subsidy. On the other hand, the more responsive is the output to a reduction in the input price, the less the subsidy.

Input subsidies are two edged: they tend to increase directly the welfare of the targeted group, but they also tend to depress output prices and thus harm the targeted group. If there is no price response to the input subsidy, because demand is perfectly elastic (i.e., $\gamma = \infty$), then

$$\delta_1 = -\frac{\rho_1}{\eta_{11}} , \tag{22}$$

and a positive subsidy level on the input price would prevail. If the government is restricted to only positive subsidies (no input taxation) then input subsidies are less likely than output subsidies because of their depressing effect on output prices. Indeed, input *taxes* may serve to minimize the cost of targeting a given level of wealth transfer, because reducing input use will decrease output and lead to an increase in output prices and profits. Thus consumers may be made worse off in order to reduce net total outlays for the industry subsidy. Input taxes and restrictions are therefore not inconsistent with targeting payments to groups of producers. In the case of input taxes, the less of the input is used by the targeted producer relative to the industry average, the greater the government will reduce that input to raise output price.

In the case of a coupled scheme for two inputs, X_1 and X_2, the rules for optimal price distortion are determined by the first-order conditions for maximizing the consumer/taxpayer's criterion function in the same manner as that for one input, and are given by

$$\frac{\eta_{1p}}{\varepsilon_0 + \gamma}(\rho_0 + \delta_1\varepsilon_1 + \delta_2\varepsilon_2) = \rho_1 + \delta_1\eta_{11} + \delta_2\eta_{12} , \tag{23a}$$

and

$$\frac{\eta_{2p}}{\varepsilon_0 + \gamma}(\rho_0 + \delta_1\varepsilon_1 + \delta_2\varepsilon_2) = \rho_2 + \delta_1\eta_{21} + \delta_2\eta_{22} . \tag{23b}$$

Writing $\alpha_i = \eta_{ip}/(\varepsilon_p + \gamma)$, we solve expressions (23a) and (23b) for the optimal rates of distortion:

$$\delta_1 = \Delta^{-1}\cdot[(\eta_{22} - \alpha_2\varepsilon_2)(\alpha_1\rho_0 - \rho_1) - (\eta_{12} - \alpha_1\varepsilon_2)(\alpha_2\rho_0 - \rho_2)] , \tag{24a}$$

and

$$\delta_2 = \Delta^{-1}\cdot[(\eta_{11} - \alpha_1\varepsilon_1)(\alpha_2\rho_0 - \rho_2) - (\eta_{21} - \alpha_2\varepsilon_1)(\alpha_1\rho_0 - \rho_1)] ; \tag{24b}$$

where $\Delta = [(\eta_{11} - \alpha_1\varepsilon_1)(\eta_{22} - \alpha_2\varepsilon_2) - (\eta_{21} - \alpha_1\varepsilon_2)(\eta_{12} - \alpha_2\varepsilon_1)] > 0$, assuming that the second-order conditions for maximization hold. Again, if the innovator uses relatively more of one input than another, then that input would tend to be subsidized to a greater degree. If, however, the total industry demand for the input is responsive to price changes, then that input will tend to receive less subsidy. Expressions (24a) and (24b) also demonstrate the importance of the distortions to the use of all inputs created by a subsidy on a single input price. Even if an input is relatively unresponsive to changes in its own price, but the other input demands are very responsive, then the subsidy will tend to be less on that input. Note that the subsidy rates can be both positive and negative, and optimal targeting of benefits to innovators can involve simultaneously the subsidization of some inputs and the taxation of others.

Sufficient conditions for which both subsidy and tax holds are

$$\frac{\rho_1}{\eta_{1p}} > \frac{\rho_0}{\varepsilon_p + \gamma} > \frac{\rho_2}{\eta_{2p}} , \tag{25}$$

and the inputs are complementary: $\eta_{12}, \eta_{21} > 0$. The intuition is that the subsidy will be attached to the input more heavily used by the targeted group relative to the industry's average and the tax will be attached to the input least used relative to the industry's average. One should note that the first input need not be used in greater quantity than the second, nor have a larger cost share, but simply the innovator's use relative to the noninnovator's is greater. For example, with the introduction of the public good, the

innovator may use less of one good, say, land (X_2), in order to produce the same level of output, but use more of another input, say, irrigation water (X_1). Then optimal targeting would entail a tax or restrictions on land and a subsidy on water. Note also that the use of land by the targeted firm may be greater than the industry average (ρ_2), but the increase in use of land over the industry average is *less* than the relative increase in output. Thus with targeting, a seeming contradiction in agricultural policies is dispelled: input subsidies and taxes may exist simultaneously. In general, taxes or restrictions will exist on traditional inputs, those less relied on by innovators to produce the same level of output. Subsidies will exist for "advanced" inputs, new technologies, or those inputs (although traditional) used in relatively greater amounts due to the public good, such as fuel or water.

If there exist only two inputs, then

$$\eta_{ip} + \eta_{ii} + \eta_{ij} = 0 \text{ , for } i, j = 1, 2 \text{ .} \tag{26}$$

The case of a two-input production function simplifies the analysis considerably. In particular, we can rank subsidy rates by reference to two parameters: the level of relative use of the input by the targeted group, and the responsiveness of the total industry demands for the inputs with respect to output price. Applying (26) in (25), we may obtain the following

Proposition 4: For two inputs, $\delta_1 > \delta_2$ if and only if $\rho_1/\eta_{1p} > \rho_2/\eta_{2p}$.

Intuitively, each η_{ip} is a measure of the social costs of distorting the use of input i, and each ρ_i is a measure of the ability to target a group via a subsidy on input i. Therefore, it is in the consumer/taxpayer's best interest to distort input prices according to the heterogeneity of firm input use weighted by the inefficiencies in production caused by the subsidies.

3.3 Both Output and Input Subsidies

Typically, governments distort the prices in both output and input markets, but rely predominantly on a single carrier of a subsidy. We may gain some insight into

Typically governments distort the prices in both output and input markets, but rely predominantly on a single carrier of a subsidy. We may gain some insight into the selection of the portfolio of subsidies by examining the case of a subsidy on output and a single input. Now the the consumer/taxpayer acting as the government has a choice over the three distinct carriers of the subsidy: output price, input price, and a per-capita transfer. Suppose the government has already selected the candidate for input subsidy, in this case X_1. This selection can be made for extraneous reasons, such as ease of administration, or for reasons of efficiency: the input is the least distorting. The criterion function for selection the optimal levels of s, d, and r is formally represented as

$$\max_{s_1 d_1} W = \int_p^\infty D(z)dz - sS(p + s, w - d) - d_1 X_1 - N[\pi_0 - \pi(p + s, w - d)] \tag{27}$$

where d is a vector of zeros except for the first element d_1. The first-order conditions for selection of the optimal subsidy rates σ an δ_1 are given by

$$\rho_0 - \sigma\varepsilon_p + \delta_1\varepsilon_1 = 0, \tag{28a}$$

and

$$\rho_1 - \sigma\eta_{1p} + \delta_1\eta_{11_1} = 0. \tag{28b}$$

From expressions (28a and (28b) the subsidy rates are explicitly solved:

$$\sigma = \frac{-\eta_{11}\rho_0 + \varepsilon_1\rho_1}{-\eta_{11}\varepsilon_p + \varepsilon_1\eta_{1p}}, \tag{29a}$$

$$\delta_1 = \frac{-\eta_{1p}\rho_0 + \varepsilon_p\rho_1}{-\eta_{11}\varepsilon_p + \varepsilon_1\eta_{1p}}; \tag{29b}$$
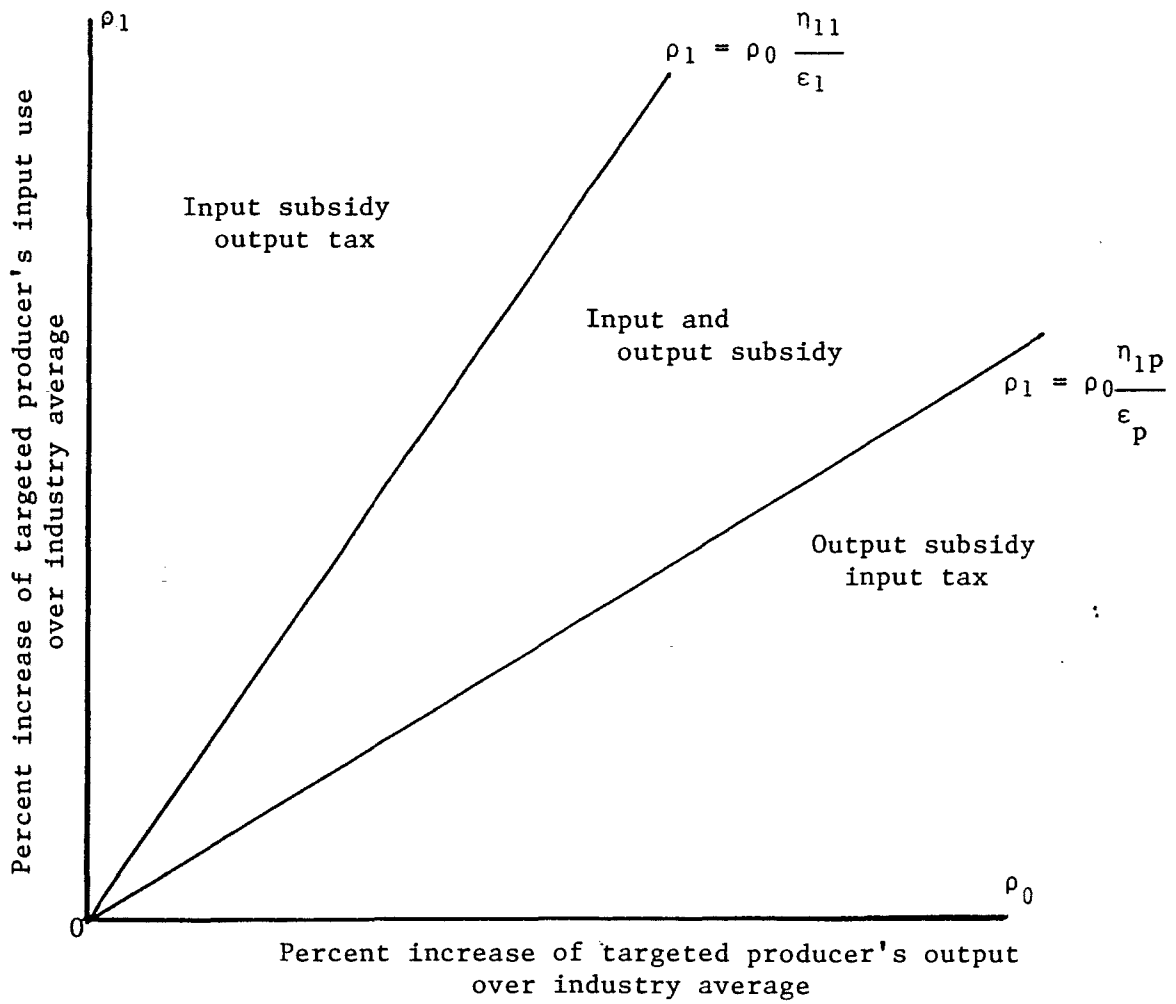
where $(-\eta_{11}\varepsilon_p + \varepsilon_1\eta_{1p}) > 0$ for the second-order conditions for a maximum to hold.

Proposition 5: With intervention in both an input and output market, a positive input subsidy will occur if and only if $\rho_1/\eta_{1p} > \rho_0/\varepsilon_p$, which is a condition similar to the case with two input subsidies without output subsidy. If we allow negative input

subsidies, then the input will be taxed if $\rho_1/\eta_{1p} < \rho_0/\varepsilon_p$. *A positive output subsidy will exist if and only if* $-\rho_0\eta_{11} > -\varepsilon_1\rho_1$ *-- which will certainly hold if* $\rho_1/\eta_{1p} < \rho_0/\varepsilon_p$, *that is, if inputs are taxed.*

Again, as before in the case of two input subsidies, intuitively the input will be subsidized if the targeted producer is more easily distinguished by his input response to the public good rather than his output response. If the relative increase in input use by the targeted group is sufficiently greater than the relative increase in output, then the government will rely more on input subsidy, and less on output subsidy, perhaps even taxing output. Figure 1 illustrates the regions where input and output subsidies or taxes (if permitted) are optimally used as functions of the ability to target payments via coupled policies.

This discussion demonstrates that the use of seemingly contradictory policies of both distorting subsidies and taxes in agricultural sectors has a logic when government payments are made to target a certain set of producers. It has been noted that in may less developed countries, the government typically subsidizes input use and taxes output. The subsidy is more often than not attached to an input, such as fertilizer, used more heavily by innovators (World Bank [1986], pp. 94-103). If the output expansion of the targeted group is not all that great relative to the industry's average, then a tax is spread more evenly over producers, although the subsidy is concentrated. More generally, advances or policy changes that affect management or production practices of a targeted group, without significantly affecting the use of any specific input, are more likely to be accompanied by an output subsidy with zero input subsidies or an input tax. Countries relying more heavily on advances to management or on diffuse improvements in production, will tend to have output subsidies. Countries where producers tend to be differentiated by management innovations would have more output subsidies relative to input subsidies. If, on the other hand, public research and development of new technologies or infrastructure is targeted to specific inputs, then

$$\rho_1 = \rho_0 \frac{\eta_{11}}{\epsilon_1}$$

Input subsidy
output tax

Input and
output subsidy

$$\rho_1 = \rho_0 \frac{\eta_{1p}}{\epsilon_p}$$

Output subsidy
input tax

Percent increase of targeted producer's input use over industry average

Percent increase of targeted producer's output over industry average

NOTE: η_{11} = Own-price demand elasticity for inut 1.

η_{1p} = Demand elasticity for input 1 with respect to a change in output price.

ϵ_p = Supply elasticity with respect to output price

ϵ_1 = Supply elasticity with respect to input price.

Figure 1. Regions of Optimal Subsidy or Tax on Output and a Single Input as Functions of the Ability to Target Payments via Coupled Payments.

subsidies will be tagged to those particular inputs, if it is likely that some producers will more readily innovate than others.

If a country's research and development (R&D) effort is broad, in the sense that any particular input is not *expected* to be used more by innovators than another input, then output subsidies are more likely to be observed. For example, in the United States a large R&D effort in agriculture may produce advances in a variety of input uses. It is difficult to predict where advances will occur, but that some advance will occur and output increase is almost a certainty. Particular ρ_i/η_{ip} for inputs are likely to be small relative to the ρ_0/ε_p for the output, in an expectation sense, implying distorting output subsidies to assure the political support of the R&D effort. By contrast, in countries seeking to expand production by application of *already developed* technologies, where the particular input requirements of the advances are known, the use of input subsidies will be a more efficient means of targeting compensatory payments. If the difference in use of the subsidized input by innovators relative to noninnovators is sufficiently great, then output would tend to be taxed, reducing net government outlays to the industry.

3.4 Complete Control over Producer Prices

Suppose the consumer/taxpayer as the government can tax and subsidize producers at will, only constrained to keep the cth producer indifferent to some advance. The government's criterion function now becomes

$$\max_{sd} \ W = \int_p^\infty D(z)\,dz - sS - \sum d_i X_i - N[\pi_0 - \pi(p+s, w-d)] \ . \tag{30}$$

The first-order conditions for subsidies and taxes now take the form

$$S\rho_0 - s\frac{\partial S}{\partial p} - d_1\frac{\partial X_1}{\partial p} - d_2\frac{\partial X_2}{\partial p} - \ldots - d_K\frac{\partial X_K}{\partial p} = 0 \ , \tag{31a}$$

$$X_i\rho_i + s\frac{\partial S}{\partial w_i} + d_1\frac{\partial X_1}{\partial w_i} + d_2\frac{\partial X_2}{\partial w_i} + \ldots + d_K\frac{\partial X_K}{\partial w_i} = 0 \ , \text{ for all } i \ , \tag{31b}$$

where again $\rho_0 = y_c/\bar{y} - 1$, and $\rho_i = x_{ci}/\bar{x}_i - 1$. Noting that $\hat{p}(\partial S/\partial p) + \sum \hat{w}_i(\partial S/\partial w_i) = 0$ and that $\hat{p}(\partial X_j/\partial p) + \sum \hat{w}_i(\partial X_j/\partial w_i) = 0$ for all j, we may sum the first-order conditions in (31) to find $\hat{p}S\rho_0 - \sum \rho_i \hat{w}_i X_i = 0$. This in turn implies

$$\pi(\hat{p}, \hat{w} \mid \alpha_c) = \bar{\pi}(\hat{p}, \hat{w}) . \tag{32}$$

That is, the government will set s and d such that the targeted firm earns the average profit. The lump-sum payment is then set to make up the difference between π_0 and $\bar{\pi}$, or to tax the producer: $r = \pi_0 - \bar{\pi}$. One should note that with full control over all producer prices, at least one subsidy is redundant. In particular, the use of an output subsidy is like a proportional change in all input subsidies. Therefore, with full control over input prices, an output subsidy can be synthesized.

The case of *equi-proportional* input subsidies can be extended to include the case of price effects of subsidies and the simultaneous choice between distorting and lump-sum payments. We may write the decision rules for input subsidies, without output subsidy, as

$$S\frac{\partial p}{\partial d_j}[\rho_0 - S^{-1}\sum d_i \frac{\partial X_i}{\partial p}] + X_j\rho_j + \sum d_i \frac{\partial X_j}{\partial w_i} = 0 \text{, for all } i = 1, K . \tag{33}$$

Note that with equi-proportional input subsidies the following conditions hold.

$$\sum d_i \frac{\partial X_i}{\partial p} = -\sum \frac{d_i}{w_i - d_i} \frac{\partial S}{\partial w_i}(w_i - d_i) = -\delta \sum \frac{\partial S}{\partial w_i}(w_i - d_i) = \delta p\frac{\partial S}{\partial p} = \delta \varepsilon_p S . \tag{34}$$

And similarly, $\sum d_i(\partial X_j/\partial w_i) = -\delta \eta_{jp} X_j$. We may thus rewrite the first-order conditions in (33) as

$$\frac{S}{X_j}\frac{\partial p}{\partial d_j}(\rho_0 - \delta\varepsilon_0) + (\rho_j - \delta\eta_{jp}) = 0 . \tag{35}$$

Recalling that $(S/X_j)\cdot(\partial p/\partial d_j) = -\eta_{jp}/(\varepsilon_p + \gamma)$ leads to the following proposition.

Proposition 6: An equi-proportional subsidy on inputs is consistent with maximizing consumer/taxpayer interest if and only if

$$\frac{\rho_j}{\eta_{jp}} = \delta + \frac{\varepsilon_p}{\varepsilon_p + \gamma}(\frac{\rho_0}{\varepsilon_p} - \delta) \text{ , for all } j \text{ .} \tag{36}$$

This proposition implies that the deviation of the targeted producer from average input use, relative to the elasticity of total utilization of the input with respect to output price, be a constant proportion across all inputs. The optimal rate of subsidy, δ, will be affected by the indirect influence of distortion on market price. The output price distortion, however, does not affect the conditions under which equi-proportional subsidies are optimal. This is because the distorting affect on output price feeds back into the cost of the coupled scheme and producer profits, but it does not alter the marginal rate of technical substitution between inputs. Driving the market output price down, by increasing input subsidies proportionally decreases the profitability of any level of output, but the marginal rates of technical substitution remain unaffected by this feedback.

4. Concluding Remarks

There are several broad conclusions that may be drawn from the foregoing analysis. First, when encouraging policy reform of distorting policies, it is important to keep in mind that lump-sum, nondistorting transfer schemes are not necessarily in the best interests of those who *seem* to bear the brunt of costly agricultural policies, namely, consumers and taxpayers. Distorting payments allow a means of differentiating between firms that might otherwise be indistinguishable. Per-capita payments may be more efficient in the classic sense of maximizing social welfare when all other policies are held constant, but the actual objectives of governments may be much more complicated. In particular, when wealth transfers are used as remuneration in order to gain the acquiescence of a group of firms harmed by some other policy, then the optimal choice of subsidy involves some distortion.

Forcing nondistorting transfer schemes on a government may actually be counter-productive to the economic well-being of a country, because the use of

nondistorting payments does not eliminate the desire for compensation in order to gain support for public goods that expand society's economic pie. Decoupling payments from production decisions may in fact raise the cost of assuring the political viability of largely beneficial advances that carry adverse distributional effects on some potent groups. Governments would then forego some of these beneficial policies that otherwise would be undertaken, and *total* social welfare would suffer.

Second, distorting coupled subsidies for the purpose of compensating subsets of firms are likely where producers are expected to be heterogeneous in their abilities to take advantage of a policy that harms the industry on average. Government sponsorship of technical advancement, whether in the form of R&D or adaptation of already-developed practices, is a particularly notable example of a policy that promotes society's economic welfare but may harm particular groups of producers. Some firms are better able to make use of technical advances, because of their geographic location, size, managerial abilities, and so forth. In order to judge the consumer/taxpayer's commitment to distorting subsidies -- and thus the outsider's ability to encourage their elimination -- one should examine the characteristics of the subsidized industry. If it is monolithic, or centralized, or highly concentrated, then the use of distorting payments is unlikely to make sense from the consumer/taxpayer's standpoint. If the industry is dispersed, heterogeneous, and decentralized, then distorting payments may actually have greater political support outside the industry itself.

Third, there are tradeoffs between distinguishing targeted producers via distorting payments, and the social costs of distortion. There are three aspects to this point: (1) If the targeted producer uses one input relative to the industry average, more than another input, then that input will be more heavily subsidized relative to others. (2) If total industry demand is responsive to input price decreases, then that input will tend to receive less subsidy. (3) Even if an input demand is relatively less price responsive to its own price, but other input demands are responsive to a change in that price, then

the input in question will tend to not have a subsidy.

Fourth, output subsidies will be preferred over input subsidies when input-specific advances are not anticipated. Input subsidies are likely when a government has complete information of the particulars of future advances. Developing countries that anticipate changes in their agricultural sectors due to the adaptation of technical advances developed elsewhere are likely to tailor compensating subsidies specific to those advances. This implies a greater reliance on input subsidies, perhaps with output taxes. As a country adopts the pre-existing technical advances suitable to it, and (at least, in terms of agricultural production) catches up to the rest of the world, the government will likely begin anticipating unknown, as-yet-to-be-seen advances developed elsewhere and domestically. Therefore, as a country's agricultural sector advances, one is likely to see a change from input subsidization (perhaps with an output tax) to output subsidization (perhaps with input taxes or restrictions).

Fifth, and finally, reductions in output subsidies due, to say, foreign interventions, will increase input subsidies or lower taxes; the reduction in total market distortion will be less than the reduction in a particular market. Therefore, an outsider judging its success at encouraging policy reform in a country must not take the superficial reduction of output-price distortion as an accurate measure.

Footnotes

1/ Making all prices endogenous would complicate the analysis, but not alter the basic results.

2/ We are abstracting from administrative costs that may varying across types of output and input markets.

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