Efficient Redistribution through Commodity Markets

Bruce Gardner

Efficiency in redistribution is measured in terms of deadweight loss generated per dollar of economic surplus transferred between consumers and producers of a commodity by means of market intervention. The implications of supply and demand elasticities for efficiency in redistribution are examined with special attention to the comparison of production control and deficiency payment programs. The results may be used to aid in the evaluation of commodity programs and as a basis for consideration of the hypothesis that observed policies are efficient, given the political power of interest groups.

Key words: agricultural policy, income distribution.

Governmental intervention in farm commodity markets often has been evaluated using analytical procedures developed by Nerlove and Wallace to measure deadweight losses. These losses are the costs of obtaining various social and political objectives. The view in this paper is that the central purpose of intervention is to redistribute income to producers from consumers or taxpayers. In this context, the social cost of intervention is the deadweight loss per dollar transferred. This general view is not novel (Dardis, Josling). The purpose here is to treat it more systematically than previously.

The main innovation in this paper is to tie deadweight losses based on consumers' and producers' surpluses explicitly to surplus transfers. This can be important. Consider a particular example: a market with linear supply and demand curves of equal slope. In this situation, the standard approach holds that a production-control program to achieve price $\bar{P}$ (figure 1) at output Q_0 generates deadweight losses equal to area $b + c$. A deficiency-payment program that guaranteed producers price $\bar{P}$ would result in output Q_1, with deadweight losses of area e. Since $e = b + c$, the deadweight losses are equal and there is no way to choose between them on efficiency grounds [Wallace, p. 585, eq. (4)]. However, the deadweight loss per dollar transferred to producers is quite different.

The amount transferred under the production control is the area a (price gain on output Q_o) minus c (rents lost on $Q_e - Q_o$). The amount transferred with the deficiency payment is area $a + b + d$. The deadweight loss per dollar transferred with production control is equal to $e/(a - c)$; for the payment program it is $e/(a + b + d)$. Since the latter denominator is larger, the ratio is smaller—the deadweight loss ratio is smaller for the payment program. Thus, payments are a more efficient redistributive mechanism even though the standard triangles are equal for both programs.

Quantifying Efficiency in Redistribution

It would be useful to have formulas analogous to those developed by Nerlove and Wallace, but specified to measure efficiency in redistribution. To visualize what is measured by such formulas, a graphical approach can illustrate the tradeoff between consumers' and producers' surpluses (Josling 1974). This surplus transformation curve is analogous to the economy-wide constraint on income redistribution which Bator calls the utility possibilities frontier.

The author is a professor in the Department of Agricultural and Resource economics, University of Maryland.

Scientific Article No. A-3323 of the Maryland Agricultural Experiment Station. The Center for the Study of the Economy and the State, University of Chicago, supported this research.

Parts of this material have been presented in seminars at the Universities of Chicago, Maryland, Purdue, Illinois, and Texas A&M.

The author is grateful for comments received from participants on these occasions, and from the *AJAE* reviewers.

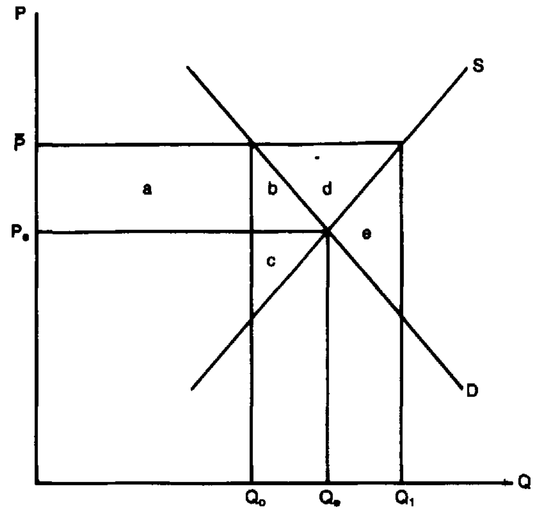

Figure 1. Deadweight losses

Consider the inverse (price-dependent) demand and supply curves

(1) $$P = D(Q),$$

(2) $$P = S(Q).$$

Let redistribution from consumers to producers occur through production controls. Such intervention results in output $\hat{Q}$, which is less than or equal to the unregulated competitive output, Q_e.

The resulting consumer and producer surpluses (CS and PS, respectively) are defined as

(3) $$CS = \int_0^{\hat{Q}} D(Q)dQ - D(\hat{Q})\hat{Q},$$

(4) $$PS = D(\hat{Q})\hat{Q} - \int_0^{\hat{Q}} S(Q)dQ.$$

The surplus transformation curve, T, is

(5) $$T = T(CS, PS),$$

where the attainable CS, PS pairs are traced out by variations of the policy variable $\hat{Q}$. For example, consider linear demand and supply functions:

(6) $$P = a_0 + a_1Q;\ a_1 < 0$$

(7) $$P = b_0 + b_1Q;\ b_1 > 0,\ 0 < b_0 < a_0.$$

The surpluses with production controls are

(8) $$CS = -\tfrac{1}{2}a_1\hat{Q}^2$$

(9) $$PS = (a_0 - b_0)\ Q + (a_1 - \tfrac{1}{2}b_1)\hat{Q}^2.$$

The surplus transformation curve is obtained by solving (8) for $\hat{Q}$ and substituting in (9), to obtain

(10)
$$PS = \frac{(a_0 - b_0)}{\sqrt{-a_1/2}}\sqrt{CS} + \frac{2a_1 - b_1}{-a_1}\,CS,$$

which is equation (5) for the linear case.

An example of equation (10) is shown in figure 2 as the solid curve to the left of point E, attained when $Q = Q_e$. It is analogous to Bator's endowment point. For given supply and demand curves, E results in the maximum sum of consumers' and producers' surpluses. At this point the marginal rate of transformation between PS and CS is -1.[1]

Intervention that favors producers generates points to the left of E. The maximum producers' surplus is obtained at point M. This reflects monopoly production [confirm by differentiating (10) with respect to CS and equating it to zero]. Thus, intervention favoring producers yields points between E and M on the surplus transformation curve, such as R. At this point consumers lose ΔCS and producers gain ΔPS.

Efficiency at the margin is measured by the slope of the surplus transformation curve. If it is -1, then a dollar given up by consumers yields a dollar gained by producers. This could occur (theoretically) through a lump-sum transfer but not market intervention. The greater the slope's departure from -1, the less efficient the redistribution. The general expression for the slope is obtained from equations (3) and (4) as

(11) $$\frac{dPS}{dCS} = \frac{dPS/dQ}{dCS/dQ}$$

$$= \frac{D'(Q)\hat{Q} + D(\hat{Q}) - S(\hat{Q})}{-D'(Q)\hat{Q}}.$$

For an intuitive grasp of this slope's determinants, consider the cases of linear and constant-elasticity (log-linear) demand and supply curves. For the linear case, differentiate equation (10) with respect to PS using equation (8) to replace CS, and substitute $(a_0 - b_0) = Q_e(b_1 - a_1)$ to obtain

(12) $$\frac{dPS}{dCS} = \frac{b_1 - a_1}{a_1}\left(1 - \frac{Q_e}{\hat{Q}}\right) - 1.$$

The slope is negative for $\hat{Q}$ between Q_e and Q_m, the output that maximizes PS. It increases from -1 at Q_e to 0 at Q_m. Thus, the marginal efficiency of redistribution depends on the

[1] Derivations of these and following mathematical results are available from the author.

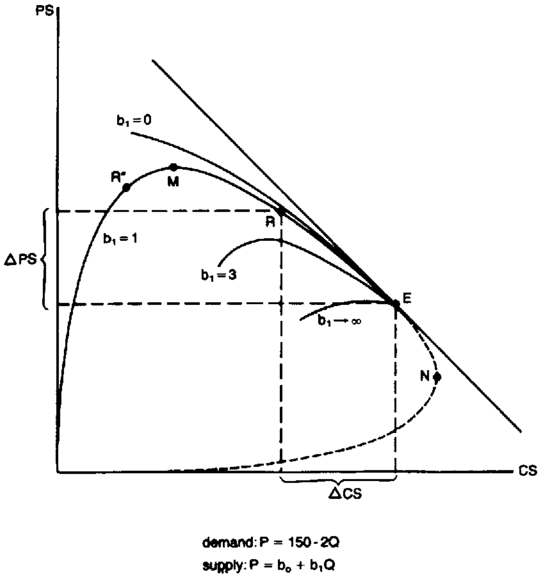

Figure 2. Surplus transformation curves: production control

supply and demand slopes and the extent of production cutback.

For log-linear supply and demand curves, the slope of the surplus transformation curve is

$$(13) \quad \frac{dPS}{dCS} = -\eta\,[1 - (\hat{Q}/Q_e)^A] - 1,$$

where $A = 1/\epsilon - 1/\eta$ with η the elasticity of demand (a negative number) and ϵ the elasticity of supply. The effect of an increase in ϵ is to make the first term of (13), which is always positive, smaller. Therefore, the slope of the surplus transformation curve, for any given restriction $\hat{Q}$, becomes closer to -1. This means that the marginal deadweight loss per dollar transferred (the "price of redistribution") is reduced. The effect of an absolute increase in η is to make the first term of (13) larger. Consequently, the marginal deadweight loss per dollar transferred is increased. Thus, the social cost of redistribution to producers is reduced by a lower demand elasticity or a higher supply elasticity.

Figure 2 shows the effect of a change in supply elasticity for the linear case from perfectly elastic ($b_1 = 0$) to perfectly inelastic ($b_1 \to \infty$). Equations (11) to (13) each imply that the slope is more sensitive to a change in supply elasticity, the more elastic is the demand function. Note that when $b_1 \to \infty$ (perfectly inelastic supply) in figure 2, it is impossible to redistribute much surplus to producers. This occurs because PS is equal to total revenue and the elasticity of demand is only a little less than 1. For elastic demand curves at E, producers' surplus is reduced by output control when supply is perfectly inelastic. Fixed supply can generate corner solutions at E. The slope of the transformation curve at E is not -1 when $b_1 \to \infty$. Generally, there will be corners in the surplus transformation curve if output restriction is capable of driving supply price to zero.

These are the same qualitative results derived by Wallace. However, we can estimate more readily how sensitive marginal deadweight losses per dollar redistributed are to changes in supply and demand parameters. Note that by setting the derivatives of (11) or (12) with respect to $\hat{Q}$ equal to zero, the size of production cutback that maximizes PS can be found. This quantity (the output sold under pure monopoly) identifies the point at which further production control makes producers and consumers both worse off.

For a given finite change such as E to R, we can analyze the total redistribution, $\Delta PS/\Delta CS$. It is this trade-off, not the marginal redistributions, that is most directly comparable to deadweight losses analyzed by Nerlove and Wallace. Since $D = \Delta PS - \Delta CS$, where D is the deadweight loss, we can estimate $\Delta PS/\Delta CS$ if we have an estimate of ΔPS or ΔCS in addition to D. Rosine and Helmberger estimated that in 1970 \$4,829 million was distributed away from consumers and taxpayers in order to give farmers \$2,140 million. This implies that $\Delta PS/\Delta CS = .44$, but it does not provide an estimate of the marginal rate of substitution (dPS/dCS) at the restricted equilibrium point.

Analytically, the total redistribution to producers in the linear case is

$$(14) \quad \frac{\Delta PS}{\Delta CS} = \frac{(b_1/a_1)(1 - R) - 2}{1 + R},$$

where $R = Q_e/\hat{Q}$.

Total redistribution in the constant-elasticity case is

$$(15) \quad \frac{\Delta PS}{\Delta CS} = (1 + \eta)\left[\frac{1}{B}\left(\frac{1 - R^{-B}}{1 - R^{-C}}\right) - 1\right], \qquad (\eta \neq 1)$$

where $B = 1 + (1/\epsilon)$ and $C = 1 + (1/\eta)$.

An example will clarify these formulas and their relationship to the Nerlove/Wallace results. Suppose a commodity has (constant) elasticities of demand and supply of $\eta = -0.5$ and $\epsilon = 0.2$, respectively, and that a production-control program reduces output by 20% ($R = Q_e/\hat{Q} = 1.25$). Applying formula (11), $\Delta PS/\Delta CS = -0.75$. For simplicity let $P_e = 1$ and $Q_e = 1$ so that values redistributed are shares of equilibrium total revenue. The constant-elasticity assumption implies that $\hat{P}$ rises to 1.56 when $\hat{Q}$ falls to 0.8. Thus, $\Delta CS = -0.50$, $\Delta PS/\Delta CS = -0.75$, and $\Delta PS - 0.38$. The sum of ΔPS and ΔCS gives the deadweight loss, 0.12, or 12% of total revenue (P_eQ_e). The corresponding formula in Wallace (p. 582) gives the deadweight loss as $\frac{1}{2}(.5)(.45)^2\ (1 + .5/.2) = 0.18$. The difference occurs because the Wallace formula is an approximation involving substantial error for large changes. The contribution of equation (15), besides being exact for constant elasticities, is that it ties deadweight losses explicitly to surplus redistribution. The contribution of equation (13), which has no parallel in the Nerlove/Wallace treatment, is to show the marginal costs of further redistribution. In the present example, $dPS/dCS = -.60$. Thus, at the margin, a dollar transferred from consumers results in a 60¢ gain for producers and a 40¢ deadweight loss. A marginal rate of surplus transformation less than the total gain in PS per dollar of CS lost is a quite general result. It follows from the convexity of the surplus transformation curve.

Redistribution toward Consumers

An extension of the surplus transformation curve to the right of point E involves intervention to redistribute income from producers to consumers. The mechanism could be a price ceiling below the unregulated market price. Then equations (3) and (4) become

$$(16) \qquad CS = \int_0^{\hat{Q}} D(Q)dQ - S(\hat{Q})\hat{Q},$$

$$(17) \qquad PS = S(\hat{Q})\hat{Q} - \int_0^{\hat{Q}} S(Q)dQ,$$

where $\hat{Q}$ is output forthcoming at the ceiling price, $S(\hat{Q})$. The surplus transformation curve for a linear example is to the right of point E in figure 2. It also has a slope of -1 at point E. The maximum consumers' surplus is at point N, the monopsony outcome. Equilibria favoring consumers lie between points E and N.

The producer- and consumer-favoring surplus transformation curves meet with equal slope at point E. They form a continuous, smooth function describing all surplus-distributing possibilities available by ouput-restricting intervention. The vertical (or horizontal) difference between the surplus transformation curve and its tangent at point E measures the deadweight loss from redistribution. Note that the deadweight loss accelerates with the extent of intervention in either direction from E.

Deficiency Payments

There may be more efficient ways of redistributing surpluses than output restriction. In this context, "more efficient" means capable of generating a larger sum of surpluses for a given PS/CS ratio. An intervention mechanism that has been used for some agricultural commodities is to guarantee a "target" price to produce greater than P_e. Payments equal to the difference between the target price and the market-clearing price are made. This approach, equivalent to a subsidy, increases both producers' and consumers' surpluses. But it adds costs to taxpayers who provide the payments, creating a three-group redistribution that defeats graphics like figure 2. It also introduces deadweight losses from additional taxes.

Consider consumers/taxpayers as a single group. They are, of course, the same set of people, but individuals differ in their ratio of food expenditure to tax payments. So there may be significant redistribution within the group if intervention changes from production-control to deficiency payments. This is especially important because the ratio of tax payments to food expenditures changes across income classes, rising from near zero at the lowest incomes to well over one at higher incomes. In this paper, however, taxpayer costs will be subtracted from consumers' surplus to obtain a deficiency-payment income redistribution curve from consumers/taxpayers to producers. The relevant calculation of consumers' surplus plus taxpayers' costs, T, is obtained from equation (16). Producers' surplus comes from equation (17), except that $\hat{Q} > Q_e$ for a deficiency payment. The enforced maximum price has become a guaranteed minimum price. In the linear case, we have

(18)
$$CS - T = (a_0 - b_0)\hat{Q} + (\tfrac{1}{2}a_1 - b_1)\hat{Q}^2,$$

(19)
$$PS = \tfrac{1}{2}b_1\hat{Q}^2.$$

These imply the transformation curve,

(20)
$$CS - T = \frac{(a_0 - b_0)}{\sqrt{b_1/2}} \sqrt{PS} + \frac{(a_1 - b_1)}{b_1} PS.$$

Figure 3 compares the surplus transformation curve from figure 2 with that for equation (20), using the same supply and demand functions. The lower dotted curve running northwest from point E shows the trade-off between producers' surplus and consumers' surplus minus taxpayers costs. Between points E and F the production-control approach is relatively efficient, but to the left of F deficiency payments are more efficient. The dotted transformation curve could be extended rightward from point E to generate redistribution favoring consumers. This might involve an all-or-none offer to producers to produce output $Q'(>Q_e)$ to be sold at a regulated price $P'(<P_e)$. This approach conceivably could be used to redistribute essentially all the producers' surplus to consumers, with relatively small deadweight loss. Stalinist delivery quotas at state-specified prices could approximate such a policy.

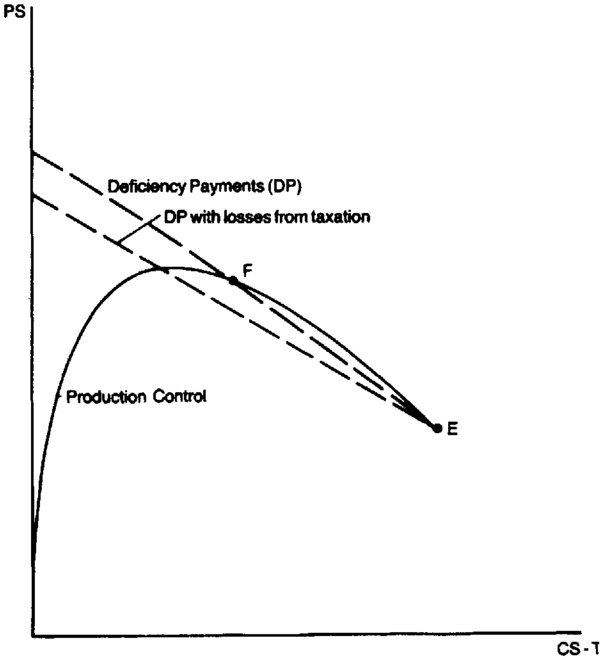

Figure 3. Surplus transformation curves for production control and subsidy

With constant elasticities, the slope of the transformation curve for a subsidy generating output $\hat{Q} > Q_e$ is

(21)
$$\frac{dPS}{dCS} = \frac{1}{-\epsilon\,[1 - (Q_e/\hat{Q})^A] - 1} - \tau.$$

Equation (21) is similar to (13) except for the parameter τ. This parameter is the deadweight loss associated with market distortion when taxes are imposed in order to raise funds for the deficiency payments. This loss is external to the regulated commodity market. It might be approximated by marginal deadweight losses per dollar of federal income tax. If this were negligible, then τ could be taken as zero. However, this loss is not negligible (Harberger, Layard). Moreover, even if the deadweight loss per dollar of additional taxes is no more than 15¢ at the margin, as suggested by Harberger, the cost per dollar transferred to producers is likely to be substantially greater. The reason is that part of the tax revenue is distributed back to consumers through lower prices. The net effectiveness of deficiency payments to producers depends on the supply and demand elasticities. (For a clear graphical analysis. see Wallace). The exact relationship, for the constant-elasticity case, is

(22)
$$\tau = D' / \left\{1 - \frac{1}{1 + \eta[1 - B(Q_e/\hat{Q})^{-A}]}\right\},$$

where D' is the deadweight loss per dollar of taxes raised. Note that if the distortion is very small, $Q_e/\hat{Q} \to 1$, and if ϵ and $-\eta$ are equal, then $\tau = 2D'$—0.30 if Harberger's estimate is correct. In this case, half the funds taxed are recycled to consumers and do not reach producers. This doubles the social cost of redistributing income.

Comparative Redistribution Efficiency—Production Controls versus Payments

Comparing equation (21) with (13) indicates that the relative size of the demand and supply elasticities determines whether a deficiency payment or production control is most efficient. But exact conditions for preferring one or the other are not obvious. Wallace's result that deadweight losses are the same when the supply and demand elasticities are equal does not hold. However, while the deadweight loss per dollar transferred is greater for the production control with equal elasticities, this advantage of deficiency payments may be offset by added social cost of raising taxes to finance the payments.[2]

A low demand elasticity or high supply elasticity tends to make production control the preferred alternative. Conversely, a low supply elasticity or a high demand elasticity favors deficiency payments. But the effect is not symmetrical, the demand elasticity being a more important determinant of efficiency for production controls and the supply elasticity more important for deficiency payments.

For linear supply and demand curves, it is even more obvious that there is no simple, general rule for tying supply and demand slopes to efficiency. This is illustrated by the crossing of the solid and dashed transformation curves in figure 3. Note also that in the limiting case in which supply is perfectly elastic, deficiency payment can generate no producers' surplus, so production control should always be chosen to aid producers. The transformation curve for deficiency payments is a horizontal line whose length measures the deadweight loss of taxpayer costs over consumers' surplus gains. If supply is perfectly inelastic a subsidy should be chosen, unless the deadweight loss per dollar raised in taxes exceeds $|\eta|$. The qualification is needed because if $\epsilon = 0$, the benefits of deficiency payments go entirely to producers. Therefore, $D' = \tau$ in equation (22), and $dPS/dCS = -1 + \tau$. For production controls we have $dPS/dCS = -(\eta + 1)$. Therefore, in order for production controls to be more efficient than the subsidy, $|\eta|$ must be less than τ (0.15 in the figure 3 example).

In general, the efficient form of intervention is determined by equations (13) and (21) for specific values of ϵ, η, τ, and $\hat{Q}/Q_e$.

Redistribution with International Trade

Consider the difference it makes for efficient redistribution if the product is exported. Assuming that foreigners have no political power in the United States, their consumers' surplus is ignored. The surplus transformation curves of figure 4 are derived from linear supply and demand curves with own-price elasticities at free-market equilibrium of −.88 for domestic demand, −3.5 for export demand, and 1.75 for supply. E' is the market equilibrium without intervention. Production controls generate the solid surplus transformation curve northwest from E'. The sum of producers' surplus and domestic consumers' surplus is no longer maximized at market equilibrium, but at point R. Thus, production controls may be chosen to maximize the sum of surpluses, whereas this could only have been accomplished by laissez-faire in figure 2 or 3.

In the example shown, a deficiency payment program is less efficient in redistributing income, indicated by the upper dotted transformation curve, in figure 4. This is because the lower market prices resulting from payments transfer income to foreign consumers, while production controls transfer income away from them. However, if the demand for exports is sufficiently elastic, this result is reversed, with deficiency payments more efficient. In such cases there is no longer a gain in the sum of surpluses from intervention. The extreme case is the small-country case of perfectly elastic export demand at the world price. In this case, production controls leave price unchanged and reduce producers' surplus, while deficiency payments result in deadweight losses smaller than in figure 4.

Trade opens up possibilities for new forms

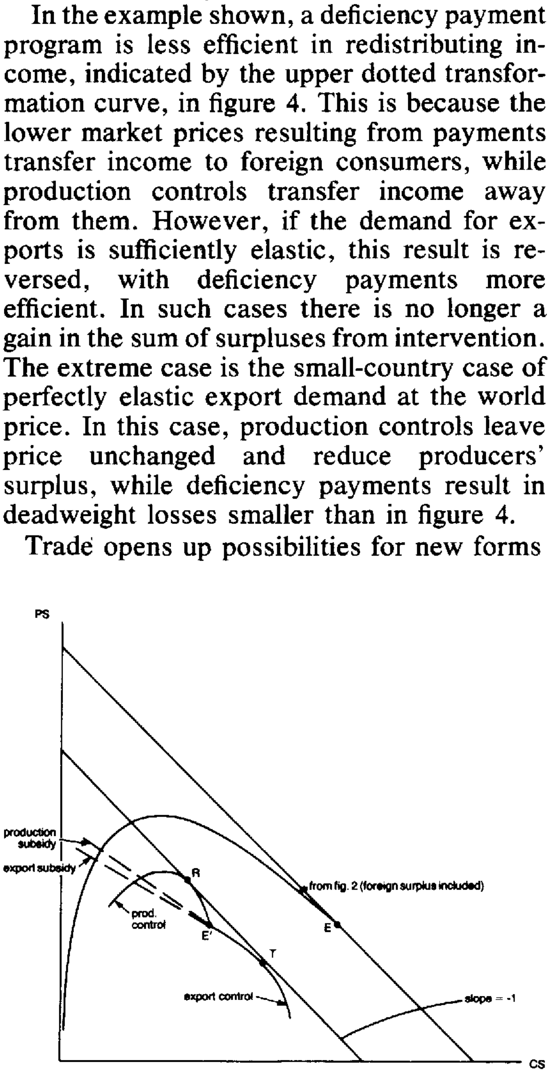

Figure 4. Surplus transformation curves (foreigners' surpluses excluded) under four forms of intervention

[2] A reviewer points out that there are administrative costs of production controls that should be taken into account; and there are also administrative costs of payment distribution, albeit probably smaller per dollar transferred than the administrative costs of production controls.

of intervention. Export quotas (or equivalent export taxes) redistribute income to consumers, shown in figure 4 by the solid surplus transformation curve southeast from E'. The sum of surpluses is increased by intervention, reaching a maximum at T, because there is redistribution away from foreign consumers. But the U.S. gainers are now consumers.[3] In such situations, production controls (favoring producers) and export controls (favoring consumers) could yield the same marginal rate of surplus transformation, with a sum of surpluses higher than the free-market equilibrium. Thus, it could be rational to switch, as in the 1970s, quite suddenly from controlling production via "set-asides" to export controls as supply/demand conditions change.

Export subsidies are harder to justify. The surplus transformation curve for an export subsidy is the lower dotted curve in figure 4. An export subsidy necessarily causes a greater domestic deadweight loss than a deficiency payment program, while the latter is less efficient than production controls. It is possible that, with domestic demand less elastic than export demand, price discrimination with export subsidies may be an efficient way to redistribute income to producers, but not as efficient as a domestic price floor plus deficiency payments.

Consider the most favorable circumstances for an export subsidy, a perfectly elastic demand function for exports, figure 5. Production controls are not useful because they reduce producers' surplus and leave price unchanged. However, a price floor for domestic consumption, or a tax on processors which is refunded to producers could be a relatively efficient transfer mechanism. A domestic price at P_d would redistribute $(P_d - P_w)\hat{Q}_d$ with the deadweight loss of the hatched triangle. An export subsidy of s per unit would redistribute an additional amount $s(\hat{Q}_s - \hat{Q}_d)$ to producers at the cost of the smaller shaded triangle. However, a deficiency payment program would transfer $s\hat{Q}_s$ to producers for the same deadweight loss. Efficiency in redistribution occurs at domestic price P_d and subsidy s at which the marginal rate of deadweight loss per dollar transferred is the same for both the domestic price floor and the production subsidy. (To be complete, the deadweight losses

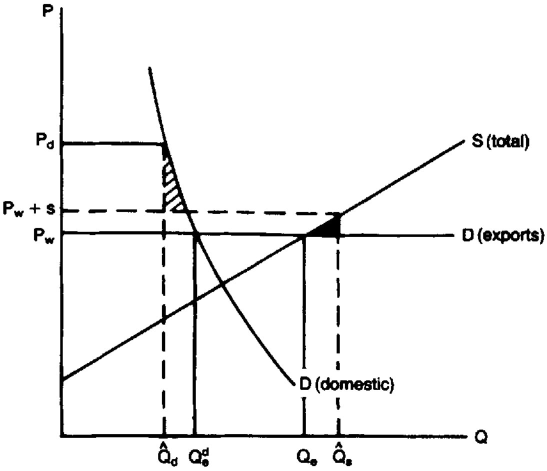

Figure 5. Inefficiency of export subsidy (world prices given)

of raising taxes to pay the subsidy must be added to the shaded triangle, but this cannot make an export subsidy more efficient than deficiency payments.)

If export demand is not perfectly elastic then the efficiency of export subsidies (and deficiency payments) is further reduced because transfers to foreign consumers will occur. The reason is shown in figure 6. Suppose we want producers to have rents attained at $\hat{P}$. This can be achieved with a deficiency payment of $\hat{P} - P_1$. Domestic and foreign consumers both pay P_1, and the deadweight loss is the shaded area. If the same producer price is achieved by an export subsidy, domestic consumers will pay $\hat{P}$. This reduces total demand at all (export) prices below $\hat{P}$ by the horizontal difference between the domestic demand curve and $\hat{Q}_d$, yielding the dashed total demand curve. Now it requires a larger subsidy

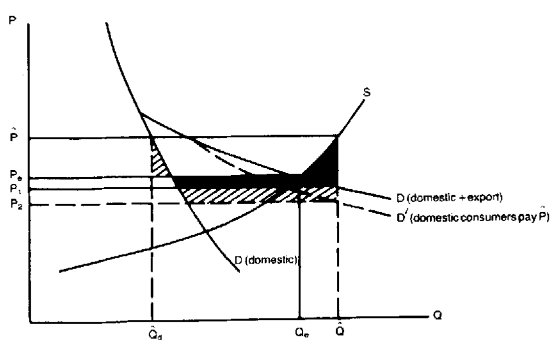

Figure 6. Export subsidy (world price influenced by exporter)

[3] Export restraints could benefit both U.S. consumers and producers if total export demand were less elastic than domestic demand.

per bushel, $\hat{P} - P_2$, to boost total demand to $\hat{Q}$. The deadweight loss is increased by the hatched areas. In figure 5, with export demand perfectly elastic at the world price, deadweight losses below P_e disappear.

Export subsidies might be efficient in adjusting to past policy "mistakes." A commodity's support price may lead to an unanticipated buildup of stocks. The stocks may have sufficiently high storage costs that receiving even, say, half the support price for them would reduce taxpayers' costs. In these circumstances, an export subsidy may be efficient. However, domestic consumption subsidies and a move toward production controls also should occur, since these are more efficient adjustment mechanisms.

Use and Limitations

The formulas of this paper can be used in two related but distinct ways, one normative and one positive. The positive application is to explore whether policy variations over time and across commodities can be explained in terms of efficiency in redistribution. For example, does the move from production controls to direct payments in cotton and rice during the 1970s reflect changes in efficiency resulting from changes in supply or demand elasticities? Can the general absence of production-control programs for livestock products be explained in terms of efficiency with relatively high demand elasticities?

The normative application is to rank prospective programs for redistributing income. Suppose, for example, that it is the intention of Congress to increase peanut growers' incomes. How should this be accomplished, and what is the marginal cost of alternative redistribution levels? The best available analysis of alternative peanut programs is Nieuwoudt, Bullock, and Mathia. Their work implies an aggregate elasticity of demand for U.S. peanuts of -1.8 and an elasticity of supply of about 4.0. U.S. policy under the Food and Agriculture Act of 1977 involves marketing controls and acreage allotments and so is basically a production-control approach.[4] But there have been continuing proposals, most recently by the Reagan administration early in 1981, to replace this program by a deficiency payment (subsidy) approach. Using the elasticities of -1.8 and $+4.0$, equations (13) and (21) imply a marginal rate of transformation of $-.74$ for a production-control and $-.27$ for a subsidy program, with a 20% quantity reduction or increase. This rough calculation indicates that it is relatively efficient to intervene with marketing controls and that the conclusion of Nieuwoudt, Bullock, and Mathia that "the target price plan would greatly reduce treasury and social costs" (p. 65) is wrong.

A serious limitation of the application just outlined, and of any use of the formulas developed, is that most commodity programs are not simply production-control or payment programs. Often they combine elements of each. However, complex schemes can be simulated for particular values of intervention variables given the values of key behavioral elasticities (or derivatives), and expectations of what such simulations would show can often be deduced from results in the simpler models. For example, the fact that inelastic demand makes production controls efficient relative to deficiency payments suggests that a higher price in the relatively inelastic fluid milk market is a means of reducing the deadweight loss per dollar transferred to dairy producers.[5]

Further limitations arise when commodity markets are interdependent. For example, the supply of soybeans, given the price of corn, is expected to be quite elastic. If intervention is to be undertaken to aid corn producers specifically (as it has been), because of the high supply elasticity, quantity controls should be more efficient than deficiency payments. The same would be true for soybeans. Yet, if we take corn and soybeans jointly, we have an aggregate commodity substantially less elastic in supply. This suggests that more efficient redistribution might result from intervention of the payment type for both products simultaneously. Indeed, extension of this reasoning suggests the most efficient method of redis-

[4] The two-tiered price supports, CCC stocks, and subsidies for crushing "excess" peanuts recently have been introduced. These complicate the program but production control remains the primary redistributive feature.

[5] CCC purchase for price-stabilizing storage between years, like the loan and FOR programs for grains, involves redistributional issues quite different from those discussed in this paper. The point about the dairy program is that it has recently involved simultaneous purchase and subsidized sales, making it equivalent to a subsidy program. In addition, as an *AJAE* reviewer points out, the subsidized consumer prices go to a particular subset of people. Therefore, in the absence of a costlessly functioning secondary resale market for subsidized dairy products, the deadweight losses are even greater than the usual triangle such as e in figure 1.

tributing income to farmers generally might be subsidies applicable to any crop.

Sector-wide intervention implies that the relevant interest group is farmers in total, not splintered commodity groups. Interaction between commodity markets has implications for the formation of political coalitions among commodity groups. The greater the cross elasticities of supply or demand between two commodities, the greater the difference between the partial and total elasticities of supply or demand, and the greater the efficiency gain in income redistribution from a program to protect both commodities jointly. Thus, apart from the political and economic factors that bear on producers' ability to form coalitions, one might expect that coalitions will be more prevalent among closely related commodities because the deadweight losses from intervention are reduced more by joint intervention under these circumstances.

In standard welfare economics the policy optimum is found with a social welfare function,

$$W = W(UP, UC), \tag{23}$$

where UP and UC are the aggregate utilities of producers and consumers. Redistributional intervention in a commodity market involves changes in (23) via a regulatory variable, X, such as a level of controlled output, a price floor, or payment per bushel. Changes in UP and UC resulting from a change in X are taken to be changes in producer and consumer surpluses, following Harberger. Therefore, the policy optimum can be found by replacing UP and UC by PS and CS, then differentiating (23) with respect to X and equating to zero, which yields

$$W_P \frac{dPS}{dX} + W_c \frac{dCS}{dX} = 0, \tag{24}$$

where W_p and W_c are the marginal contributions of producers' and consumers' surpluses to the social welfare function. The policy optimum is a point of tangency between a social welfare indifference curve and the highest attainable surplus transformation curve. With equal weights on the utilities of consumers and producers, the policy optimum is the market equilibrium.

The social welfare function is a normative concept. The comparable non-normative concept is a representation of how producers' and consumers' well-being is actually regarded in the political process. Political behavior may involve a bargaining game among interest groups (as in Zusman and Amiad) or a "policy preference function" (Rausser and Freebairn). Becker, in his analysis of the positive economics of redistribution, discusses in detail the properties of the behavioral function that replaces the social welfare function. In this context, W_c and W_p represent the (marginal) political power of consumers and producers. Thus, a point such as R in figure 2 is a political equilibrium in which the political power of producers exceeds that of consumers. The efficient redistribution hypothesis is that the political process places us at points like R, at which resources are used as efficiently as possible given the political preference function.

Concluding Remarks and Summary

The deadweight losses caused by governmental intervention in agricultural commodity markets do not tell the whole story about such intervention, nor is desire to redistribute income the sole reason for intervention. Under the assumption that it is an important reason, the deadweight losses can be viewed as a price paid to redistribute through market intervention. This paper develops models for estimating this price—the deadweight loss per dollar redistributed. It also derives for production-control and deficiency-payment programs the relationship between this price and its determinants—supply and demand elasticities, the extent of intervention, and the deadweight loss from raising general tax revenues. Qualitative results are also obtained for intervention when the export market is important.

In general, redistributive efficiency increases as either the supply or the demand function becomes less elastic. The efficient method of intervention depends on which function is less elastic. Inelastic demand favors production controls, and inelastic supply a deficiency payment approach. If demand is inelastic enough, less than about -0.15 in the cases considered in this paper, production controls are more efficient even than lump sum transfers to producers. This is because of deadweight losses associated with the taxes necessary for payments.

For intervention with an exported product, it is shown that deficiency payments are generally preferable to an export subsidy. Yet if the exporter is not a price taker in world markets, production controls may be more efficient than either type of subsidy. Moreover, under shifting economic conditions or political power, it may be efficient to shift between production controls (favoring producers) and export controls (favoring consumers).

The usefulness of the exact results generated by the formulas developed in the paper depends on having reliable estimates of supply and demand elasticities. These are often lacking. Nonetheless, it may still be of value to know exactly how much difference it makes for efficiency in distribution if the supply elasticity, say, is ½ or 1½. And the formulas can also be informative about the value of better information on elasticities. If costs of redistribution are sensitive to potential error in elasticities, it will be worthwhile to make the econometric effort necessary to sharpen our estimates. And if data do not permit accurate estimation, we can at least assess more exactly the range of likely errors in our redistributive analyses.

[Received October 1981; revision accepted September 1982.]

References

Bator, Francis M. "The Simple Analytics of Welfare Maximization." *Amer. Econ. Rev.* 47(1957):22–29.

Becker, Gary S. "A Positive Theory of the Redistribution of Income and Political Behavior." CSES Work. Pap., University of Chicago, Oct. 1980.

Dardis, Rachel. "The Welfare Cost of Grain Protection in the United Kingdom." *J. Farm Econ.* 49(1967):597–609.

Harberger, A. C. "On the Use of Distributional Weights in Social Cost-Benefit Analysis." *J. Polit. Econ.* 86(1978):S87–S120.

Josling, T. E. "Agricultural Policies in Developed Countries: A Review." *J. Agr. Econ.* 25(1974):220–64.

———. "A Formal Approach to Agricultural Policy." *J. Agr. Econ.* 20(1969):175–91.

Layard, Richard. "On the Use of Distributional Weights in Cost-Benefit Analysis." *J. Polit. Econ.* 88(1980): 1041–47.

Nerlove, Marc. *The Dynamics of Supply.* Baltimore MD: Johns Hopkins University Press, 1958.

Nieuwoudt, W., J. B. Bullock, and G. Mathia. "Alternative Peanut Programs: An Economic Analysis." North Carolina Agr. Exp. Sta. Tech. Bull. No. 242, May 1976.

Rausser, G. C., and J. W. Freebairn. "Estimation of Policy Preference Functions: An Application to U.S. Beef Import Quotas." *Rev. Econ. and Statist.* 56(1974):437–49.

Rosine, J., and P. Helmberger. "A Neoclassical Analysis of the U.S. Farm Sector, 1948–1970." *Amer. J. Agr. Econ.* 56(1974):717–29.

Wallace, T. D. "Measures of Social Costs of Agricultural Programs." *J. Farm Econ.* 44(1962):580–94.

Zusman, P., and A. Amiad. "A Quantitative Investigation of a Political Economy—The Israeli Dairy Program." *Amer. J. Agr. Econ.* 59(1977):88–98.