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Efficient Redistribution in Agricultural Commodity Markets

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CENTER FOR THE STUDY
OF THE ECONOMY AND THE STATE-

EFFICIENT REDISTRIBUTION IN
AGRICULTURAL COMMODITY MARKETS

Bruce L. Gardner

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CENTER FOR THE STUDY
OF THE ECONOMY AND THE STATE
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Efficient Redistribution in Agricultural Commodity Markets

Bruce L. Gardner*

Introduction

Of the many possible reasons for governmental intervention in the commodity markets, near the top of any list must be an intention to redistribute income toward farmers and away from nonfarmers. The many and diverse empirical studies of farm commodity programs (e.g., Rosine and Helmlinger, Nelson and Cochrane, D. Johnson, and earlier work reviewed in Brandow) disagree on analytical methods and estimated magnitudes, but all agree that there has in fact been such redistribution. The aim of this paper is to improve our understanding of redistributive intervention in agriculture--why observed variations in the form and extent of intervention have occurred over time, and from one commodity to another at a given point in time.

Some of the empirical studies just cited, and others such as Wallace, P. Johnson, Hushak, and Ippolito and Masson, are concerned with the deadweight losses (or "welfare costs") resulting from such intervention. The present study is, too, but from a different perspective. While the existence of deadweight losses is often used as ammunition in arguments against farm programs, they do not necessarily indicate that the government is uninterested in efficiency. It may in fact be engaging in efficient redistribution. This paper develops the concept of efficient redistribution in the context of an agricultural commodity market, presents an analytical framework for comparing deadweight losses associated with transfers, discusses alternative hypotheses, and puts forth a little

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empirical evidence that generally supports the hypothesis of efficient redistribution, with suggestions for more definitive tests.

The Hypothesis of Efficient Redistribution

"The methods used to accomplish any given end tend to be the most efficient available, in the public as well as the market sector." (Becker, 1976, p. 248). This view may strike one as plausible or implausible based on prior experience, but the issue from the point of view of positive economics is how to test it. It needs, first of all, a more precise, i.e., formal, specification. A substantial step in this direction with reference to income redistribution has been taken in Becker (1980). He represents the results of political pressures brought to bear as a "political preference function" which is defined for a set individuals as a function of their utilities (or alternatively, full incomes). Starting from an endowment of utility for each individual, higher values of the political preference function may be attained by redistribution of income. Given the impossibility of distortionless transfers, this insures the existence of deadweight losses. But competition for political office results in intervention that is least inefficient of the alternatives available. Thus, the deadweight losses will in some sense be minimized. The result is a political equilibrium analogous to a market equilibrium. The marginal rate of substitution between individuals' utilities in the political preference function is equated to the marginal rate of transformation between utilities on the technical opportunity set for redistribution.

Intervention in a commodity market involves primarily redistribution between consumers and producers of the regulated commodity. In this context, we define political preferences on the utilities of consumers

and producers, assuming initially that the individuals within each group are identical. The consumers all have the same tastes and full incomes, and the producers all own identical bundles of resources and opportunities (rents exist but are the same fraction of each producer's income).

The (aggregated) political preference function is

$$(1) \quad V = V(U_p, U_c),$$

where U_p and U_c are the sums of utilities of producers and consumers.

In the study of redistributive intervention in a commodity market, we are interested in changes in (1) resulting from intervention:

$$(1a) \quad dV = \left(\frac{\partial V}{\partial U_p} \cdot \frac{\partial U_p}{\partial X} + \frac{\partial V}{\partial U_c} \cdot \frac{\partial U_c}{\partial X} \right) dX$$

where X is the regulatory variable, such as a level of controlled output or a price floor.

The relevant changes in U_p and U_c resulting from a change in X are taken to be changes in producers' and consumers' surpluses, following Harberger (1971). Therefore, political indifference curves defined by $dV = 0$ can be specified as politically weighted changes in the surpluses.

This specification is in the same general spirit as in Rausser and Freebairn, and Peltzman. Peltzman's "politician's objective function" or "majority generating function" (Peltzman, p. 222) contains price paid by consumers and the profits of producers rather than surpluses. Rausser and Freebairn's "policy preference function" contains consumer expenditures and producers' returns, and also the preferences of the policymakers for intervention. This last element will be omitted for the time being. Indeed, while it will be convenient to assume at some points that V is convex and homothetic, I don't have much to say about the political preference function. This topic is treated in depth by Becker (1980) in his general analysis of the positive economics of

redistribution, and Zusman and Amiad (1977) present an interesting application of bargaining among interest groups in arriving at a constrained maximum. For the issue of redistributive intervention in a particular commodity market, it is possible to be more specific about the opportunity set for redistribution than has been done in work available to date. Because a sharp specification of the opportunity set is important in testing the hypothesis of efficient redistribution in commodity markets, it is undertaken in some detail in the following sections.

The Surplus Transformation Curve and Deadweight Losses

The constraint on redistribution of surpluses is the surplus transformation curve,

$$(2) \quad T = T(CS, PS).$$

When surpluses are redistributed from producers to consumers by means of production controls as is done under current law by means of marketing quotas in tobacco and formerly for cotton and grains, intervention results in output \hat{Q} , which is less than or equal to Q_e , unregulated competitive output.

For an example of a surplus transformation curve, consider linear demand and supply functions:

$$(3) \quad P = D(Q) = a + bQ ; \quad 0 > b > -\infty$$

$$(4) \quad P = S(Q) = c + dQ ; \quad c < a, \infty > c > 0$$

The resulting consumers' and producers' surpluses are:

$$(5) \quad CS = \int_0^{\hat{Q}} D(Q)dQ - D(\hat{Q})\hat{Q} = -1/2 b\hat{Q}^2$$

$$(6) \quad PS = D(\hat{Q})\hat{Q} - \int_0^{\hat{Q}} S(Q)dQ = (a - c)\hat{Q} + (b - 1/2d)\hat{Q}^2$$

Using (5) and (6) to eliminate \hat{Q} ,

$$(7) \quad PS = \frac{a - c}{\sqrt{-b/2}} \sqrt{CS} + \frac{2b - d}{-b} CS,$$

we have equation (2) for the linear case.

An example of what equation (7) looks like is shown in figure 1 as the solid curve to the left of point E. Point E is attained when $\hat{Q} = Q_e$. It is analogous to the endowment point in Becker (1980). For given supply and demand curves, E is the point of maximum sum of consumers' and producers' surpluses, where the marginal rate of transformation between PS and CS is -1 .^{1/}

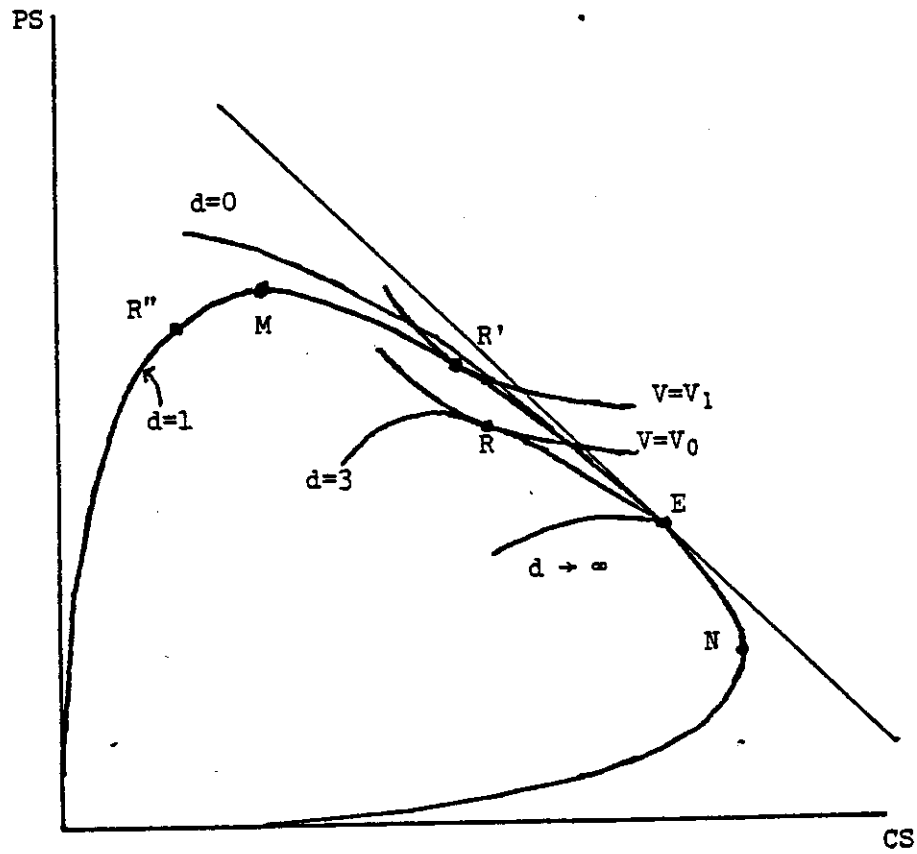
If the marginal political preferences for incomes of producers and consumers were equal, then the political equilibrium would be the unregulated market equilibrium. The existence of intervention that favors producers implies a political equilibrium to the left of E. This means that political indifference can be maintained at the margin by taking \$1 from consumers and transferring less than \$1 to producers, revealing the amount by which producers are politically favored. The maximum producers' surplus is obtained at point M, which results from monopoly production (as can be confirmed by differentiating (6) with respect to Q or (7) with respect to CS and equating to zero). Intervention favoring producers will thus normally yield equilibrium between points E and M on the surplus transformation curve.

[A possible exception with equilibrium to the left of M would arise if for some reason the political preference function placed a negative value on consumers' surplus. This might occur if consumption of the good considered is thought to be a nuisance by enough people. An example might be tobacco. Production would not necessarily be reduced to zero because the loss of producers' surplus could make it politically uneconomical, thus yielding equilibrium at a point like R". Assuming that unregulated

Figure 1. Surplus Transformation Curves: Production Control

demand: $P = 150 - 2Q$

supply: $P = c + dQ$



equilibrium would occur at E, there must be some people who don't see the good as a nuisance, so this case must involve some important differences in consumers' utility functions, which violates the initial assumptions above. We need at least two kinds of consumers. Also, it might be said that if political indifference curves had a positive slope, then it would be more efficient to simply buy out the producers. This is an instance of the general question why we don't always use cash transfers to be discussed below.]

Determinants of Efficiency of Redistribution to Producers. The shape of the surplus transformation curve depends on the supply and demand functions. The slope of the transformation curve in the linear case can be calculated from equation (7):

$$(8) \quad \gamma = \frac{dPS}{dCS} = -(a-c)/b\hat{Q} + (d/b - 2),$$

using equation (5) to replace CS after differentiating equation (7). The slope is negative for all levels of Q between Q_e and monopoly output, Q_m , increasing from -1 at Q_e to 0 at Q_m .^{3/}

The determinants of the slope are more intuitively apparent in the log-linear (constant-elasticity) case:

$$(9) \quad \frac{dPS}{dCS} = -\eta(1 - (\hat{Q}/Q_e)^{\frac{1}{\epsilon} - \frac{1}{\eta}}) - 1.$$

where η is the elasticity of demand (a negative number) and ϵ is the elasticity of supply.^{4/} The effect of an increase in ϵ is to make the first term of (9), which is always positive, smaller. Therefore, the slope of the surplus transformation curve for any given restriction \hat{Q} becomes closer to -1, which means that the marginal deadweight loss

per dollar transferred, which is essentially the "price of redistribution," is reduced. The effect of an increase in (the absolute value of) n is to make the first term of (9) larger. Consequently, the marginal deadweight loss per dollar transferred is increased. Thus, the price of redistribution to producers is reduced by a low demand elasticity and a high supply elasticity, and for a given political preference function we should expect to observe more redistribution when its price is low.

Figure 1 shows the effect of a change in supply elasticity in the linear case from perfectly elastic ($d=0$) to perfectly inelastic ($d \rightarrow \infty$).^{5/} For homothetic political preferences, the changes in surplus possibilities resulting from increased supply elasticity or decreased demand elasticity result in more redistribution to producers, for example the move from R to R' in figure 1.

For a given finite change such as E to R' it is also of interest to analyze the total redistribution, $\Delta PS/\Delta CS$. This is closely related to estimation of standard triangular areas of deadweight loss. 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 redistributed away from consumers and taxpayers in order to give farmers \$2140 million. This implies that $\Delta PS/\Delta CS = .44$ but does not provide an estimate of the marginal rate of substitution (dPS/dCS) that specifies political equilibrium.

The total redistribution corresponding to equation (9) is:

$$(10) \quad \Delta CS = CS(\hat{Q}) - CS(Q_0) = -\frac{n}{n+1} A \hat{Q}^{n+1} + \frac{n}{n+1} A Q_0^{n+1}$$

and

$$(10a) \quad \begin{aligned} \Delta PS &= PS(\hat{Q}) - PS(Q_0) \\ &= A \hat{Q}^{n+1} - \frac{1}{e+1} B \hat{Q}^{e+1} - A Q_0^{n+1} + \frac{1}{e+1} B Q_0^{e+1} \end{aligned}$$

where the terms are as defined in footnote 4. Dividing (10a) by (10) and simplifying yields the average redistribution (in terms of elasticities):

$$(10b) \quad \frac{\Delta PS}{\Delta CS} = (1+n) \left[\frac{1}{1+1/\epsilon} \left\{ \frac{1-(\hat{Q}/Q_0)^{1+1/\epsilon}}{1-(\hat{Q}/Q_0)^{1+1/n}} \right\} - 1 \right].$$

Table 1 provides comparisons of marginal and average redistribution for selected parameter values.

The important general

result is that the marginal rate of transformation from (9) is always less than the total gain in PS per dollar of CS lost. This follows from the increasing marginal rate of deadweight loss (concavity of the surplus transformation curve).

Possibilities for Redistribution Toward Consumers. An extension of the surplus transformation curve to the right of point E would involve intervention to redistribute income from producers to consumers. The mechanism could be a price ceiling below the unregulated market price. Then equations (5) and (6) become

$$(11) \quad CS = \int_0^{\hat{Q}} D(Q) dQ - S(\hat{Q}) \hat{Q}$$

$$(12) \quad PS = S(\hat{Q}) \hat{Q} - \int_0^{\hat{Q}} S(Q) dQ,$$

where \hat{Q} is output forthcoming at the ceiling price, $S(\hat{Q})$. The surplus transformation curve for the linear example used above is the curve to the right of point E in figure 1. It also has a slope of -1

Table 1. Marginal and Average Producers' Benefits per Dollar of Consumer Cost.

$ n $	ϵ	marginal benefits ^{a/}	average benefits ^{b/}
0.2	0.2	-0.82	-0.87
	1.0	-0.85	-0.90
	5.0	-0.86	-0.91
1.0	0.2	-0.26	-0.55
	1.0	-0.64	-0.81
	5.0	-0.77	-0.88
5.0	0.2	2.4 ^{c/}	0.99
	1.0	0.17	-0.40
	5.0	-0.57	-0.79

^{a/} dPS/dCS from equation (9). $\hat{Q}/Q_e = 0.8$.

^{b/} $\Delta PS/\Delta CS$ from equation (10a). $\hat{Q}/Q_e = 0.8$.

^{c/} The positive sign means that when consumers' surplus is reduced, producers' surplus is reduced also. This means we are above the monopoly price, and on a positively sloping segment of the surplus transformation curve.

at point E. The maximum consumers' surplus is at point N, which corresponds to a ceiling price at the level that would be set by a monopsonist. The normal political equilibrium favoring consumers would be observed between points E and N. [The exceptional circumstances for equilibrium below point N would involve a political preference function that placed a negative value on producers' surplus from some good. Production would not necessarily be reduced to zero because the marginal loss of consumers' surplus might at some point exceed the political value of the reduction of producers' surplus.]

The producer- and consumer-favoring surplus transformation curves meet at point E and have the same slope there. Thus, they form a continuous function without corners describing all the surplus-distributing possibilities available by intervention that restricts output. The vertical (or horizontal) difference between the surplus transformation curve and its tangent at point E measures the deadweight loss resulting from redistribution. Note that the deadweight loss does not increase linearly but accelerates with the extent of intervention in either direction from E.

Production Subsidies. It is possible that there may be ways of redistributing surpluses more efficient than the surplus transformation curve for output restriction. "More efficient" means capable of generating a larger sum of surpluses for a given ratio PS/CS. An alternative approach to intervention that has been used for some agricultural commodities is to guarantee a "target" price to producers greater than P_e by making payments equal to the difference between the target price and the market-clearing price. This approach, equivalent to a production subsidy, increases both producers' and

consumers' surpluses. But it introduces costs to taxpayers who provided the payments. This creates a 3-group redistribution that defeats figure 1. It also introduces deadweight losses elsewhere due to taxes.

Consider what happens if we treat consumers/taxpayers as a single group. They are of course essentially the same set of people, but since individuals differ in the ratio of food expenditure to tax payments, there may be significant redistribution with the group in changing between a production-control and subsidy approach to intervention. This is especially important in that the ratio of tax payments to food expenditures changes by income class, rising from near zero at the lowest incomes to well over 1 at higher incomes. For the time being, however, taxpayer costs will be subtracted from consumers' surplus to obtain an income redistribution curve from consumers/taxpayers to producers for a subsidy program. The relevant calculation of consumers' surplus plus taxpayers' costs, T , is obtained from equation (11) and of producers' surplus from equation (12), except that $\hat{Q} > Q_e$ for a subsidy. The enforced maximum price has become a guaranteed minimum price. In the linear case, we have:

$$(13) \quad CS - T = (a - c) \hat{Q} + (1/2b - d) \hat{Q}^2,$$

$$(14) \quad PS = 1/2d\hat{Q}^2.$$

These imply the transformation curve,

$$(15) \quad CS - T = \frac{a - c}{\sqrt{d/2}} \sqrt{PS} + \frac{b - 2d}{d} PS.$$

This function looks a lot like (7), but differs in interesting ways. Figure 2 shows an example, comparing the surplus transformation curve from figure 1 with equation (15) for the same underlying supply and demand functions.

In the figure 2 example, the dotted curve running northwest from point E shows the tradeoff 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 the subsidy is more efficient. With relatively little political power, as measured by the equilibrium slope of political indifference curves, producers could achieve political gains through subsidies even greater than they would achieve at the monopoly output under production controls. [The dotted transformation curve could be extended rightward from point E to generate redistribution favoring consumers. This would involve something like 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 could conceivably be used to redistribute essentially all the producers' surplus to consumers, possibly with relatively small deadweight loss. An approximation of such a policy might be Stalinist delivery quotas at state-specified prices, but I don't know of U.S. examples.]

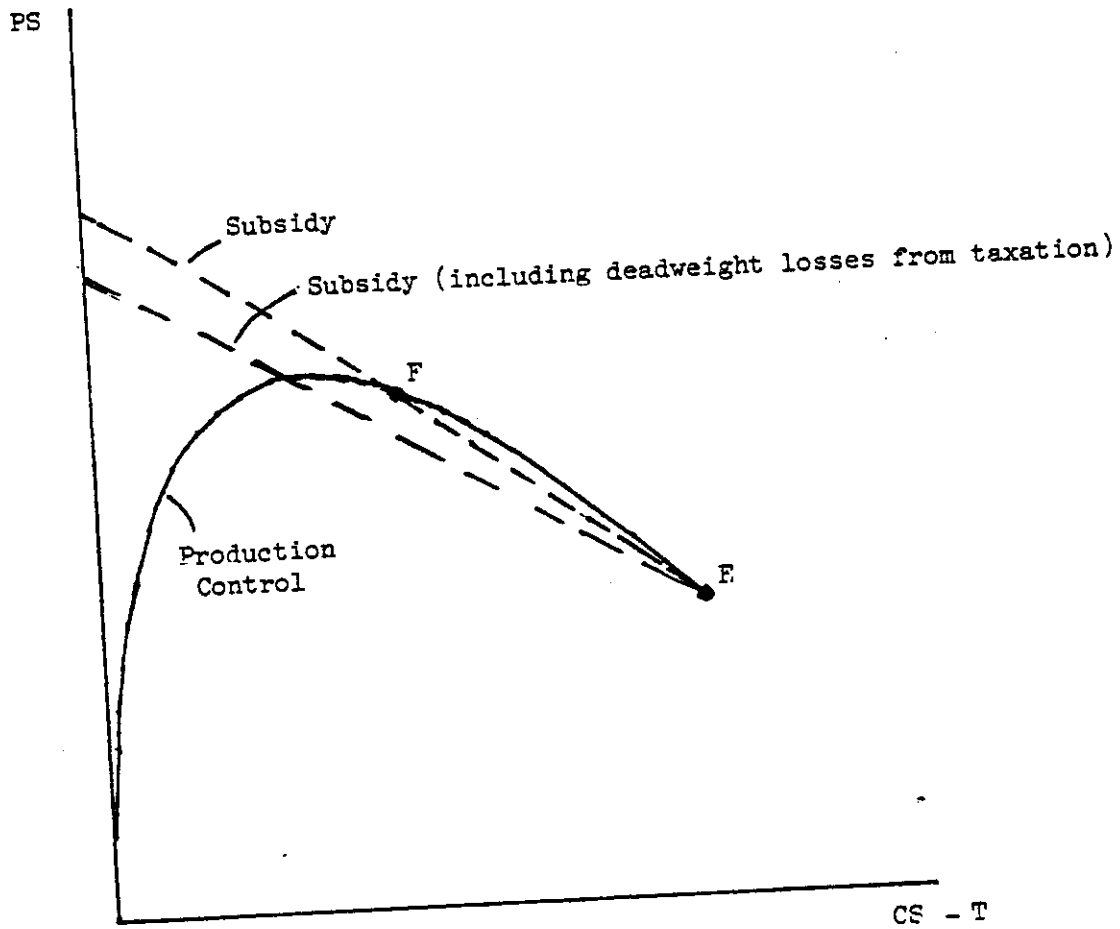
With constant elasticities, the slope of the transformation curve for a subsidy generating output $Q > Q_e$ is^{6/}

$$(16) \quad \frac{dPS}{dCS} = \frac{1}{\frac{1-\epsilon}{\epsilon} \frac{1}{\eta}} - \tau$$

$$\epsilon(Q_e/\hat{Q}) - \epsilon - 1$$

The structure of (16) is basically similar to (9), except for the addition of the parameter τ . This parameter is the deadweight loss associated with distortion of the markets in which taxes are imposed in order to raise funds for the farm subsidy payments. This is a matter external to the regulated commodity market. It might be approximated by the marginal deadweight losses per dollar raised in the federal income tax. If this were negligible, then τ could be taken as zero. However, it seems clear that this loss is not negligible (see, for

Figure 2. Surplus Transformation Curves for Production Control and Subsidy



example, the discussion in Harberger (1978, 1980) and Layard (1980)). Moreover, even if the deadweight loss per dollar of taxes raised is no more than 15 cents at the margin, as suggested by Harberger (1980), 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 getting subsidy payments to producers depends on the supply and demand elasticities. (For a clear graphical depiction, see Wallace.) The exact relationship, for the constant-elasticity case, is^{7/}

$$(16a) \quad \tau = D' / \left\{ 1 - \frac{1}{1 + \eta[1 - (1 + 1/\epsilon)(Q_e/\hat{Q})^{1/\eta - 1/\epsilon}]} \right\}$$

where D' is the deadweight loss per dollar of taxes raised. Note that if the distortion is very small, $Q_e/\hat{Q} \rightarrow 1$, and ϵ and $-\eta$ are equal, then $\tau = 2D'$, or 0.30 in the example. This reflects the fact that half the funds taxed are recycled to consumers and do not reach producers, thus doubling the social cost of raising the subsidies that do reach them.

Comparative Efficiency of Redistribution with Production Controls and Subsidies. Comparing (16) with equation (9) indicates that the relative size of the demand and supply elasticities determines whether a subsidy or production control is most efficient. But the exact conditions for preferring one or the other are not obvious. The result of Wallace that deadweight losses are the same when the supply and demand elasticities are equal does not hold. The deadweight losses for a given regulated price are the same, but a given regulated price generates more producers' surplus for a subsidy than for a production control. Thus, the deadweight loss per dollar transferred is greater for the production control. However, this advantage of a subsidy may be offset by the added social cost of raising the taxes to finance the subsidies.

In order to obtain a better grasp of how these forces influencing efficiency of redistribution work out, table 2 shows values of equations (9) and (16) for equivalent interventions. As noted earlier, a low demand elasticity or high supply elasticity promotes production control. Conversely, a low supply elasticity or a high demand elasticity promotes the use of subsidies. But the effect is not symmetrical, the demand elasticity being a much more important determinant of efficiency of production controls and the supply elasticity much more important for subsidies.^{2/} When the supply and demand elasticities are nearly the same (in absolute value), there is relatively little difference between the marginal efficiency of programs of the two types.

In the case of linear supply and demand curves, the same general results hold, but a couple of points are intuitively clearer. First, the fact that there is no simple, general rule for tying elasticities to efficiency is illustrated by the crossing of the solid and dashed transformation curves. Second, the extreme cases are more straightforwardly understood. In the limiting case in which supply is perfectly elastic, a subsidy can generate no producers' surplus, so production control should always be chosen for intervention to aid producers. The transformation curve for a subsidy is a horizontal line whose length measures the deadweight loss (excess of taxpayer costs over consumers surplus gains). At the other extreme, if supply is perfectly inelastic a subsidy should be chosen (unless the deadweight loss per dollar raised in taxes exceeds $|n|$.) The parenthetical qualification arises as follows. With $\epsilon = 0$, the benefits of a subsidy go entirely to producers. Therefore, $D' = \tau$ in equation (16a), and $dPS/dCS = -1 + \tau$. For production

Table 2. Marginal rates of transformation of surpluses (dPS/dCS)^{a/}
elasticity of demand (η)

elasticity of supply (ϵ)	elasticity of demand (η)				
	-.2	-.5	-1.0	-5.0	-100.
.2	-.82, -.74 ^{b/} (.11)	-.60, -.75 (.11)	-.26, -.77 (.10)	2.4, -.78 (.10)	66, -.78 (.10)
.5	-.84, -.58 (.14)	-.70, -.64 (.13)	-.51, -.68 (.12)	.93, -.73 (.11)	35, -.75 (.10)
1.0	-.85, -.39 (.18)	-.76, -.50 (.17)	-.64, -.58 (.15)	.17, -.70 (.11)	19, -.73 (.10)
5.0	-.86, .06 (.28)	-.81, -.03 (.31)	-.77, -.18 (.28)	-.57, -.54 (.16)	4, -.71 (.10)
100.	-.87, .33 (.34)	-.82, .30 (.43)	-.79, .44 (.48)	-.77, .25 (.43)	-.55, -.52 (.17)

^{a/} All values are calculated for a 20 percent quantity intervention ($\hat{Q}/Q_e = 0.8$ or 1.2).

^{b/} The first number in each pair is the value from equation (9)--production control--and the second from equation (16)--production subsidy. The numbers in parentheses below the production subsidy values are the deadweight losses per dollar raised in the general economy, τ in equation (16), calculated from (16a) with $D' = 0.10$. This figure is shown separately because of the tenuousness of the D' value chosen. To see what dPS/dCS would have been had τ been zero, subtract the number in parentheses from the number above it. Thus, the entry at .2, -.2 becomes -.85 instead of -.74. The production subsidy would be judged more efficient if we neglected the deadweight losses associated with raising taxes for the subsidy. In this table, τ reverses the efficiency ranking of the policies only when $\epsilon = -\eta$.

controls in the linear case, we find that equation (8) with perfectly inelastic supply, $dPS/dCS = -a/b\hat{Q} - 2$. Since the elasticity of demand at \hat{Q} is $\eta = a/b\hat{Q} + 1$, we have $dPS/dCS = -(\eta + 1)$. Therefore, in order for production controls to be more efficient than the subsidy, $|\eta|$ must be less than $\tau (=0.15$ in the figure 2 example). Thus, the elasticity of demand must be less than the deadweight loss per dollar raised through taxes in order for production controls to be more efficient than a subsidy.

In general, the efficient form of intervention must be determined by equations (9) and (16) for the particular values of ϵ , η , τ , and \hat{Q}/Q_e that are of interest. However, the sample of results in table 2 suggests some rules of thumb in forecasting the extent and form of intervention under the efficient redistribution hypothesis.

The most important consideration is the minimum value of ϵ and $|\eta|$. For example, if either is 0.2 or less, appropriate choice of policy regime guarantees a marginal rate of transformation of surpluses of -0.75 . Given the value of this minimum, the efficiency of redistribution is increased, the greater the value of the other elasticity. The form of intervention depends, roughly, on which elasticity is the minimum and which the maximum. Thus, the hypotheses resulting from this discussion are: (1) the extent of intervention increases as $\min(\epsilon, |\eta|)$ decreases, where ϵ and η are the elasticities of supply and demand at market equilibrium, (2) for a given value of $\min(\epsilon, |\eta|)$, the extent of intervention increases as $\max(\epsilon, |\eta|)$ increases, and (3) the likelihood of observing production controls increases as an index $I = \epsilon - |\eta|$ increases, and the likelihood of subsidies increases as I decreases.

Shifts in Supply and Demand. One of the issues considered in Peltzman (1976) is the consequence of changes in costs and demand. Many agricultural economists have explained past intervention in agriculture as an attempt to solve a "farm problem" arising from technical progress increasing the supply of farm products faster than the growth of demand. Since demand is inelastic, real farm prices fall. However, discussions of these events have not indicated why falling farm prices should lead to intervention. (It is also not clear that producers' surplus would be reduced by these events. Indeed, if supply is linear with unchanged slope, and supply goes to zero before price goes to zero, then producers' surplus should have increased.)

The hypothesis of efficient redistribution suggests considering how shifts in supply and demand change the surplus transformation curve. For a given political preference function, what can be predicted about the changes in position of equilibrium, and associated marginal political influence, that result from underlying supply or demand changes? This question involves difficulties that did not arise in considering the effects of changes in supply and demand slopes on the slopes of surplus transformation curves. Now we must specify shifts in the market equilibrium point that is the basis from which redistribution takes place.

Consider consumers' gains from an increase in supply due to technical progress. Whether expenditures increase or decrease depends on the elasticity of demand being greater than or less than -1 , and in any case the change does not measure a change consumers' well-being. The best indicator of utility change is the gain in consumers' surplus. But if demand increases, it is not obvious that

consumers' surplus is an appropriate indicator. It could be that supply has been reduced for a substitute commodity, or that tastes have changed. Nonetheless, it seems likely that the main changes in demand for agricultural products have been due to population and real income change, rather than changing tastes for different commodities or supply changes for substitutes. (Substitution may be important for narrowly defined commodities within the set of agricultural commodities, as will be discussed below.) For the present it is assumed the relevant shift in the endowment point for consumers is the change in consumers' surplus at market equilibrium.

Similarly, the amount of producers' gains at the market equilibrium may be measured as the gain in producers' surplus. As with consumers, there are circumstances where this measure of gain is misleading. The supply function could become less elastic yet generate the same market price if producers' options for reallocating agricultural resources to nonagricultural uses were reduced. This quite properly changes the slope of the surplus transformation curve and hence equilibrium redistribution. But it is not clear that the producers' endowment point has changed. Their incomes are the same. In the following discussion we will consider the consequences of measuring producers' endowment point in terms of both producers' surplus at market equilibrium and factor incomes at market equilibrium.

Endowments measured as surpluses. Consider first how the ratio of producers' surplus to consumers' surplus changes at market equilibrium when supply or demand shift. The endowments of consumers' and producers' surpluses depend on the whole length of the supply and demand functions, so that changes in PS/CS are sensitive to changes in the functions at all points. An increase in demand or supply is taken to mean the same change in

quantity at each price, or the same change in price at each quantity, that is, a horizontally or vertically parallel shift. This is most simply represented in the linear case, where the shift is a change in intercept, a or c in equations (3) and (4). Since the ratio of consumers' to producers' surplus at market equilibrium is

$$PS/CS = \frac{1/2d Q_e^2}{-1/2b Q_e^2} = -d/b,$$

it follows immediately that a change in a or c leaves the ratio of surpluses unchanged. Therefore, with homothetic political preferences there is no intervention in a previously unregulated market when supply or demand shift.

If intervention is already occurring (the case considered in Peltzman, 1976, pp. 224 ff.), it is not immediately apparent how CS/PS changes with a shift in supply or demand. In the linear case, the ratio of surpluses when output is held at \hat{Q} to benefit producers is

$$(17) \quad PS/CS = \frac{2(a-c)/\hat{Q} + (2b-d)}{-b}$$

Consider an expansion of demand. With no change in \hat{Q} , the additional revenue generated goes to producers, so PS/CS falls. To investigate an equivalent degree of intervention after the demand increase, allow \hat{Q} to increase such that it is the same fraction k of Q_e as before the shift; that is $\hat{Q} = kQ_e$. Returning to equation (8) for the slope of the surplus transformation curve, we find that increasing a while maintaining $Q = kQ_e$ leaves the slope unchanged. Since k is an arbitrary constant, $0 < k < 1$, this establishes that changing a generates a homothetic family of surplus transformation curves.^{10/} The same is true for changes in c . Therefore, such shifts in demand

or supply have no effect on the degree of intervention if political preferences are homothetic.

Nevertheless, the regulated price will not remain a constant percentage above the changed market equilibrium price, unless $\epsilon = |\eta|$, i.e., the elasticity of supply at Q_e equals the elasticity of demand. Otherwise, even though $\hat{Q} = kQ_e$, $\hat{P} \neq kP_e$. The reason is that while the difference between the regulated (demand) price $D(\hat{Q})$ and the supply price $S(\hat{Q})$ is proportional to P_e , the division between $D(\hat{Q}) - P_e$ and $P_e - S(\hat{Q})$ depends on η and ϵ . If $|\eta| < \epsilon$, a demand increase will cause a larger change in \hat{P} than in P_e , while a supply increase (cost reduction) will cause a smaller change in \hat{P} than in P_e . Thus regulation amplifies price changes resulting from demand shifts and buffers price changes resulting from supply shifts. This is the opposite of the result obtained in Peltzman (1976, p.227). However, when $|\eta| > \epsilon$, price changes due to demand shifts are moderated by regulation, and supply shifts are amplified, which is Peltzman's result. (But in this case the subsidy approach is preferred to production control anyway.)

Moreover, although intervention is unchanged in that k remains constant along with PS/CS and $\Delta PS/\Delta CS$, it is true that the amount transferred does change -- both PS and CS change, but in the same proportion. So if we are explaining the aggregate amounts redistributed rather than the rate of output reduction or subsidy per unit output, there is a straightforward size effect in that aggregate redistribution is proportional to total revenue in the market. This "size" effect should be distinguished, however, from the argument in Pincus (1975) that the size of an industry should influence (in his case) the rate of tariff protection.

Endowments measured as factor incomes. Consider now, in the linear case, how shifts in demand and supply affect the ratio of consumers' surplus to producers' incomes. The ratio is

$$(18) \quad \phi = CS/P \cdot Q = -1/2bQ/(a+bQ).$$

Using the equilibrium condition that (3) = (4) to solve for Q_e and substituting in (18), the ratio is

$$(19) \quad \phi = -1/2b(a-c)/(ad-cb).$$

To explore how ϕ changes, consider first an increase in demand, i.e., an increase in a . The result is

$$(20) \quad \frac{d\phi}{da} = \frac{-1/2b - \phi d}{ad - cb}$$

The sign of this expression depends on the relative slopes of the supply and demand function. If $|b| = d$, then $\phi = 1/2$ and equation (20) is zero. If $|b| > d$, that is, demand is relatively inelastic at point E, then $\phi > 1/2$ and equation (20) is negative. Therefore, an increase in demand will move E such that consumers gain relative to producers and, with a homothetic political preference function, policy will adjust to favor producers. But if supply is relatively inelastic, policy will adjust to favor consumers.

Consider a decrease in supply, such as from a rise in opportunity costs of factors of production. This could take the form of an increase in c or an increase in d . For an increase in c , we have

$$(21) \quad \frac{d\phi}{dc} = \frac{b(\phi - 1/2)}{ad - cb}$$

Again, if $|b| = d$, then equation (21) is zero. If $|b| > d$, then equation (21) is negative. For an increase in d , we have

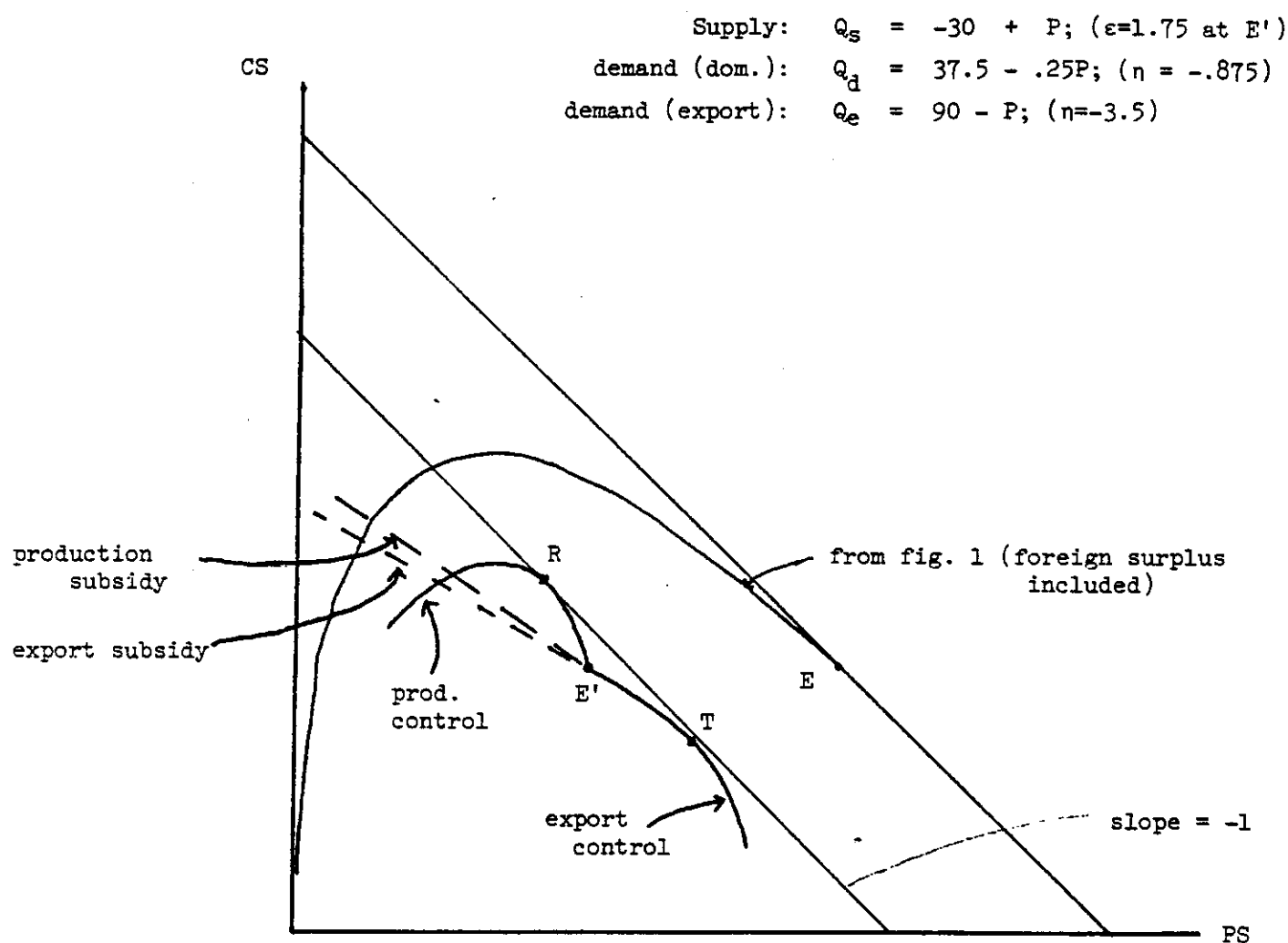
$$(22) \quad \frac{d\theta}{dd} = \frac{-a\theta}{ad-cb}$$

This expression is negative.

Returning to the earlier discussion of technical progress, this could be represented as a decrease in c or a decrease in d . Equations (21) and (22) imply that if demand is less elastic than supply, either representation makes producers worse off relative to consumers at market equilibrium. Therefore, with homothetic political preferences, policy shifts to favor producers. However, if demand is more elastic than supply, induced intervention should tend to favor consumers if technical progress takes the form of a reduction in c .

Foreigners. Export demand is important for some agricultural commodities. Assuming that foreign buyers have no political power in the United States, consumers' surplus of foreigners is excluded. An example of how this affects the surplus transformation curve is shown in figure 3. 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, we expect intervention even if political preferences give equal weight to producers and consumers at E' . In the example shown, a subsidy to production is less efficient in redistributing income, as indicated by the upper dotted transformation curve in figure 3. This is because the subsidy transfers income to foreign consumers, while production controls transfer income away from them. However, if the demand for exports is elastic enough, this result is reversed--production subsidies are more efficient--although in such cases there is no longer a gain in the sum of surpluses from intervention. The extreme case is

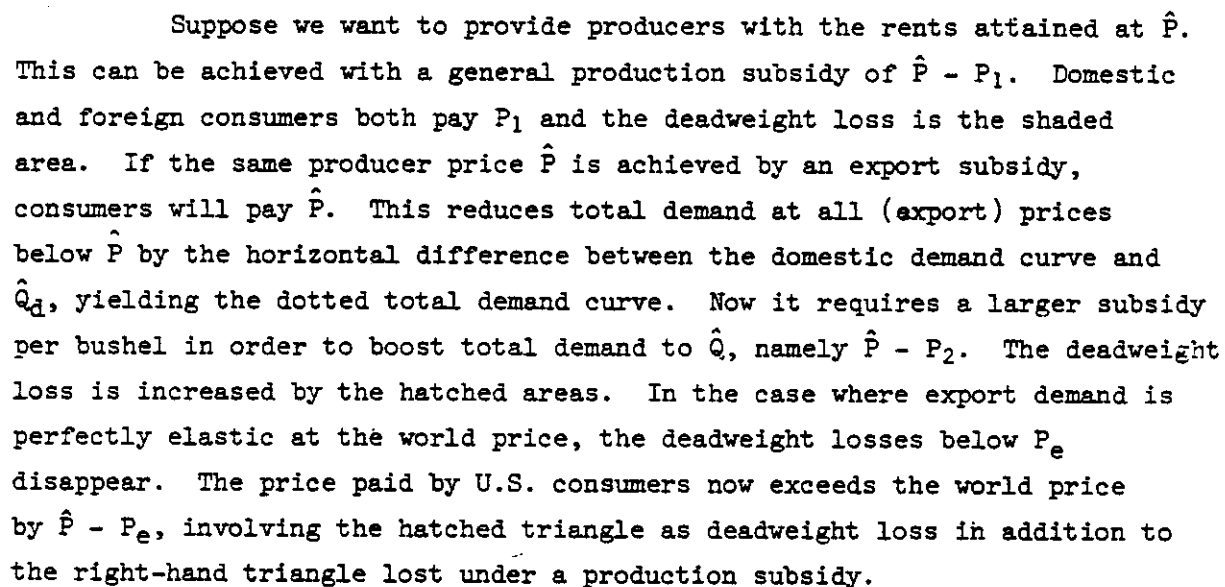
Figure 3. Surplus Transformation Curves (Foreigners' Surpluses Excluded) under Four Forms of Intervention



perfectly elastic export demand at the world price. In this case production controls leave price unchanged (as long as exports continue) and reduce producers' surplus, while subsidies result in deadweight losses smaller than in figure 3. Therefore, we predict the choice of a subsidy if income is redistributed to producers.

The presence of trade opens up possibilities for new forms of intervention. Export quotas (or equivalent export taxes, if they were constitutional) redistribute income to consumers, as shown in figure 3 by the solid surplus transformation curve southeast from E'. The sum of surpluses is increased by intervention, reaching a maximum at T, again because there is redistribution away from foreign consumers. But the U.S. gainers are now consumers.^{11/} In such situations it is possible for production controls (favoring producers) and export subsidies (favoring consumers) to be on the same political indifference curve, and both to be preferred to the free market equilibrium. Thus, it is not so surprising to see, as we have several times in the 1970s for grains, quite sudden switching from "set-asides" (controlling production) to controls on exports.

A policy that is harder to explain is export subsidies. The surplus transformation curve for an export subsidy in the figure 3 case is the lower dotted curve. An export subsidy necessarily causes a greater (domestic) deadweight loss than a general production subsidy and the latter is less efficient than production controls. This point is elaborated in figure 3a. It is possible that with domestic demand less elastic than the demand function for exports, price discrimination may be an efficient way to redistribute income to producers, but it is more efficient to achieve this result with a domestic price floor plus a general production subsidy than with an export subsidy.

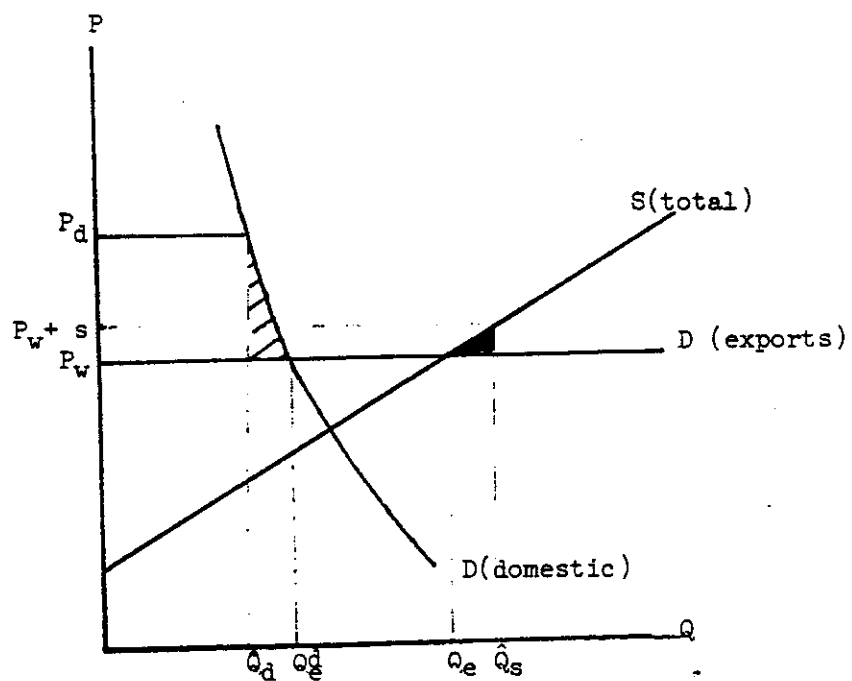


Consider the most favorable circumstances for an export subsidy, which is a perfectly elastic demand function for exports, as in figure 3b. Production controls are not a viable policy option because they reduce producers' surplus and leave price unchanged (unless production is reduced to Q_d^d). However, a price floor for domestic consumption, or a tax on processors refunded to producers (implemented in 1933-36 for wheat, corn, cotton, and livestock), could be a relatively efficient transfer mechanism. A domestic price at P_d would redistribute $(P_d - P_w)$ times \hat{Q}_d at the cost of a deadweight loss of the hatched triangle. An export subsidy of S per unit would redistribute an additional sum of S times $(\hat{Q}_s - \hat{Q}_d)$ to producers at the cost of the smaller shaded triangle. However, a general production subsidy would transfer S times \hat{Q}_s to producers for the same deadweight loss. Equilibrium would occur at domestic price P_d and subsidy s such that the marginal rate of deadweight loss per dollar transferred is the same for both the domestic price floor and the production subsidy. To have a complete accounting, the deadweight losses of raising the taxes to pay the subsidy must be added to the shaded triangle, but this cannot rehabilitate export subsidy as compared to the production subsidy.

If the demand for exports is not perfectly elastic, then the efficiency of export subsidies (as well as of production subsidies) is further reduced because transfers to foreign consumers will occur.

There are, however, reasons why an export subsidy can be a result of efficient intervention. One is that foreign consumers' surplus might make a positive contribution to the V function, i.e., foreigners have political power. We do in fact observe substantial foreign aid in food over a long historical period, at least since World War I. An observation of

Figure 3b. Inefficiency of Export Subsidy (world prices given)



the legislative process does suggest coalition between farm interests and an internationally minded "hunger lobby" (Barton 1977, Paarlberg 1980).

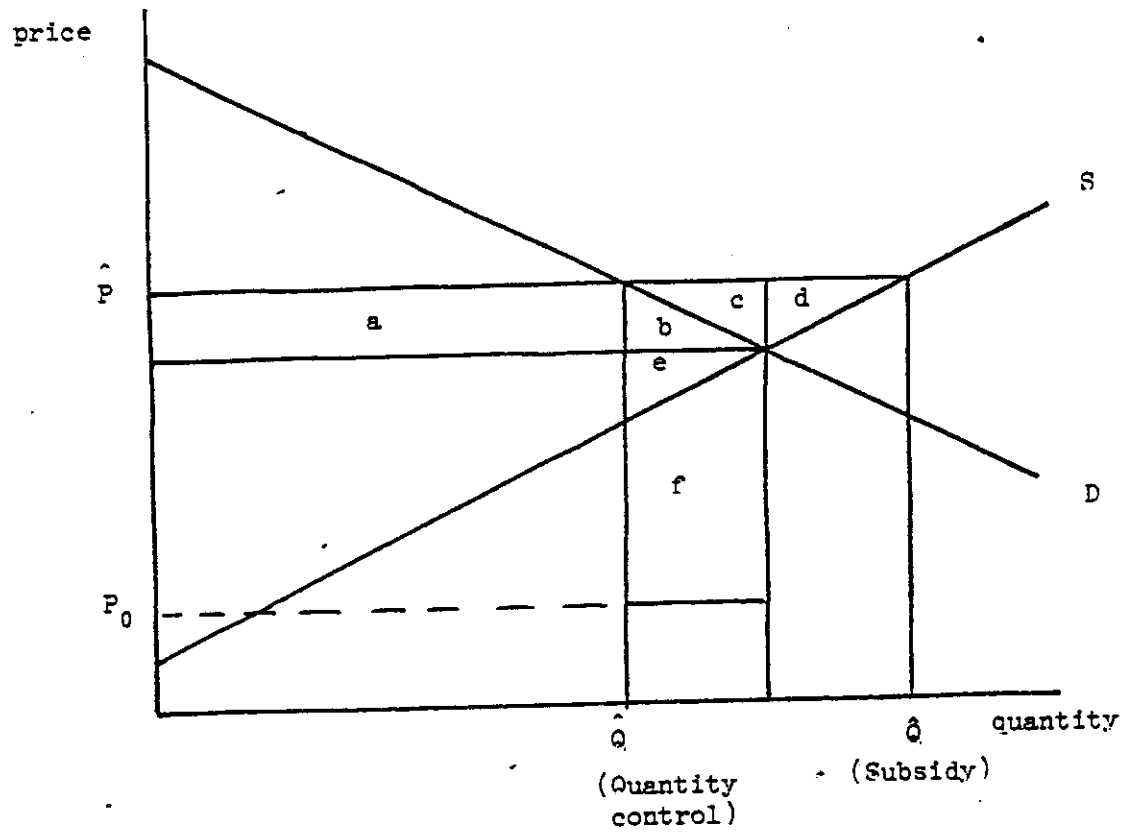
A second way in which export subsidies can be efficient is in adjusting to past policy "mistakes" (as seen in retrospect). A commodity's support price may lead to an unanticipated buildup of stocks. The stocks may have sufficiently high storage costs that receiving even, say, half the support price for them would save the taxpayers money. In these circumstances, an export subsidy may be an efficient policy choice. However, we should expect to see at the same time domestic consumption subsidies and a move toward production controls, since these are more efficient adjustment mechanisms at the initial margin. In fact, this is what we observe in the U.S. government's subsidies paid to private exporters of wheat in the 1960's through August 1972 (when we subsidized a substantial increase in exports to the Soviet Union) and to some extent in past subsidized sales of tobacco and peanut oil.

Resources. While programs for wheat, rice, feed grains, cotton, milk, peanuts, and tobacco have at times in the past (and for peanuts and tobacco, currently) contained controls on the quantity of a product sold, the more common production restraint is diversion of acreage. A factor-market constraint always yields a larger deadweight loss than an output constraint that generates the same product price increase. The reason is that there is an additional efficiency loss due to a change in relative factor prices which increases the cost of producing the constrained output (see Wallace 1962, Carlton 1979). So why do we observe acreage controls?

Two developments that are particularly notable from the point of view of the hypothesis of efficient redistribution are that mandatory

acreage controls have tended to be replaced by "voluntary" controls, and the simultaneous use of subsidies and controls. Voluntary acreage controls are essentially offers of the government to rent some of a farmer's land at announced rental rates on which the government then instructs the farmer, as the government's agent, not to grow certain crops. In the past three years under the Food and Agriculture Act of 1977, offers like this have been made to farmers for land which (the farmers certify) would otherwise have been planted to corn, barley, grain sorghum, or cotton. This approach permits a possibly significant increase in the efficiency of surplus transfer. To take a particular example, if the slopes of (linear) supply and demand curves are equal, the redistribution by means of subsidy is more efficient than production control, as mentioned earlier. But with voluntary controls, the advantage of the subsidy can be greatly reduced. In figure 4, the achievement of price (rental rate of land) \hat{P} by means of a production control or a subsidy (guaranteed price of \hat{P}) has the same deadweight loss. But the subsidy transfers $a + b + c + d$ to landowners while production controls transfer only $a - e$. Therefore, the subsidy has a smaller deadweight loss per dollar transferred. The move to voluntary controls means that the government will offer rental payments to producers sufficient to induce them to divert enough land to increase price to \hat{P} . Farmers won't volunteer unless they receive \hat{P} . Therefore, the transfer under voluntary controls is $a + b + c$, much closer to the redistribution provided by the subsidy. With a slightly greater slope of the supply curve, the availability of voluntary controls can reverse the relative efficiency of controls versus a subsidy.

Figure 4. Transfers to Landowners from Quantity Control and Subsidy.



The simultaneous use of subsidies and controls is illustrated by the current wheat program. For the 1978 wheat crop the government guaranteed producers a price of \$3.40 per bushel, and the relevant market price turned out to be \$2.90 per bushel, generating payments of \$600 million. But to qualify for these payments, producers "set aside" 9.6 million acres or about 13 percent of the preceding year's planted acreage. On the basis of an estimated 50 percent "slippage" (set-aside of unproductive land or other evasive measures by farmers) it is plausible that the output control only slightly more than offset the additional production that the subsidy would otherwise have induced. Therefore, \hat{Q} may have been quite close to Q_e . While such a combination might be a relatively efficient redistribution mechanism, there are costs involved in certifying those eligible for the program, and their compliance with set-asides. Moreover, there is a real resource-allocation cost in that some land is put to suboptimal uses, and the ratio of nonland inputs to land is too high.

From the point of view of intervention as the attainment of political equilibrium, there is a more basic reason why acreage controls might be efficient in redistribution. Just as, in Peltzman (1976), equilibrium involves different regulated prices for consumers whose demands differ, in the commodity markets we may expect to find differences in the treatment of factor owners whose supply functions differ. If the relevant interest group is composed of factor owners, then intervention in the factor market will be less costly as measured by deadweight loss per dollar transferred to the politically favored factor owners. Thus, acreage controls may be consistent with efficient redistribution, not to farmers per se, but to owners of agricultural land.

In assessing the efficiency of surplus redistribution to factor owners, the relevant demand function is not for a product but for a factor of production.

Thus, the surpluses redistributed are no longer only consumers' surpluses.^{12/} The area under the factor demand function (which permits product price and other factor prices to adjust at each point on the demand function) includes rents to suppliers competing inputs as well as consumers' surplus (Just and Hueth, 1979; Chavas and Collins, 1980).

Consider the following constant-elasticity model with two factors of production: land, L, and nonland inputs, N. The demand function for farm output is

$$(23) \quad Q = AP^\eta X^\alpha$$

where x is a (vector of) exogenous variable(s) such as population. The production function

$$(24) \quad Q = f(L, N)$$

is CRS with constant elasticity of substitution σ . The factor supply functions are

$$(25) \quad P_L = BL^{1/\epsilon_L} Y^\beta$$

$$(26) \quad P_N = CN^{1/\epsilon_N} Z^\gamma$$

where Y and Z are exogenous variables shifting the supply functions of these inputs, such as diversion payments or nonfarm wage rates, and ϵ_L and ϵ_N are elasticities of supply of land and nonland inputs. The factor market equilibrium conditions are

$$(27) \quad P_L = f_L P$$

$$(28) \quad P_N = f_N P$$

where f_L and f_N are the marginal products of L and N.

The efficiency of income transfers to factor owners depends on supply and demand elasticities. For product demand and factor supplies we already have these as η , ϵ_L , and ϵ_N . For product supply and factor demands they can be derived from appropriate changes in X, Y, or Z. The derived supply elasticity is (Muth 1965)

$$(29) \quad \epsilon_Q = \frac{\epsilon_L \epsilon_N + \sigma(\kappa_L \epsilon_L + \kappa_N \epsilon_N)}{\sigma + \kappa_L \epsilon_N + \kappa_N \epsilon_L}$$

where κ_L and κ_N are factor shares. One of the factor supply elasticities will in general be less than ϵ_Q . Therefore, it will usually be possible to use the subsidy approach to redistribute income at less deadweight loss per dollar transferred to one of the factors than to producers of the product as a group.

The derived elasticity of demand for factor L is (Floyd 1965):

$$(30) \quad \eta_L = \frac{\eta\sigma + \epsilon_N(\kappa_L\eta - \kappa_N\sigma)}{\epsilon_N + \kappa_L\sigma - \kappa_N\eta}$$

The elasticity of demand for N is the same expression with all the N and L subscripts interchanged. It is not clear a priori whether η_L or η_N are likely to differ from η in such a way as to make restraints on input quantities a less efficient transfer mechanism. Even in the simpler case where nonland inputs are perfectly elastic in supply, so that $\epsilon_N \rightarrow \infty$, we have

$$\eta_L = \kappa_L\eta - \kappa_N\sigma.$$

One cannot say a priori whether $\eta_L > \eta$. Using parameter values from work on the 1960's for U.S. agriculture as an aggregate of $\eta = -.25$, $\sigma = .4$, $\kappa_L = .22$, $\kappa_N = .78$, and ϵ_N between 1 and ∞ , we get a range for η_L from only $-.36$ to $-.37$ (because η_L is very insensitive to changes in ϵ_N at these parameter values). The relatively high demand elasticity for the factor compared to the product suggests quantity controls would be more efficient for output than for the land input.

This result reinforces the idea that conditions in the land market are relatively favorable for the subsidy approach. In fact, two of the most persistent forms of intervention in agriculture are essentially

subsidies to the use of land services. These are the Agricultural Conservation Program, which makes payments to farmers for land improvements, and the provision of subsidized credit through the Federal Land Banks. In addition, the most rapidly growing area of redistribution to farmers in the 1970's was subsidized insurance against crop failure, the main effect of which is to increase the demand for cropland services in the riskiest production areas. Moreover, subsidies to crop production in general can be taken as subsidies to landowners if the other inputs are perfectly elastic in supply or nearly so.

This may explain why subsidy programs have been directed almost entirely at crops and not at livestock products. Even the exceptions to this generalization are consistent with the joint hypothesis that the subsidy approach is chosen only when supply is inelastic and that the predominant source of inelasticity is land. Beef import restraints are a subsidy to domestic production, but the imported beef is almost entirely lean cow beef, not corn-fed steer beef. Cow beef is produced essentially by allowing animals to graze on pasture and so is in fact relatively land intensive. The same is true for the only livestock product that receives a direct production subsidy, wool.

For factors of production that are very elastic in supply, it tends to be inefficient to create rents by means of a subsidy program. However, the deadweight loss from restricting the quantity of a factor such as hired farm labor might be relatively low, depending on the elasticity of demand. In fact, intervention in the hired farm labor market has been of the quantity-control type. Although farm workers are often taken to be politically weak, with the aid of unionized labor interests they have obtained intervention equivalent to a quantity

restriction, namely the extension of the minimum wage to farm labor.

Intervention in many markets simultaneously. There is an interesting parallel between efficient redistribution and "Ramsay pricing" as developed in Bradford and Baumol (1970), Willig and Bailey (1977), and Ross (1980). This literature derives the result that regulators of a natural (decreasing-cost) monopoly can increase consumers' surplus by means of prices that differ for consumers with differing demand elasticities, and derives from observed regulated prices the implied weights of regulators in a Bergsonian social welfare function. The social welfare function has the same arguments as the political preference function used here, and the weights of the social preference function are the marginal political preferences ($\frac{\partial V}{\partial U_c}$ and $\frac{\partial V}{\partial U_p}$) in equation (1a). The optimal prices are:

$$-\eta_i \left(\frac{P_i - C_i}{P_i} \right) = R$$

for each of i goods where C is marginal cost and R is the "Ramsay number" common to all goods (Ross, p. 6). In the notation of this paper, $P_i = P_d$ and $C_i = P_s$. From equation (F-4) we have that $R = dPS/dCS + 1$, i.e., that R is the marginal deadweight loss per dollar transferred.

We may extend the Ramsay rule for optimal pricing under decreasing costs to an analogous rule for optimal intervention under increasing costs. The rule is, if producers of all farm commodities have equal political power, and there is redistribution to farmers, then farm prices should be set such that the marginal deadweight loss per dollar transferred is the same for all commodities. This will involve more redistribution to producers of commodities for which redistribution is cheaper (in terms of deadweight loss). Convexity of political indifference curves means that even though producers of all commodities have equal political

power prior to intervention, their implicit weights will change as redistribution occurs. This will dampen, but not change the direction of intervention. The resulting equilibrium condition is

$$-n_1 \left(\frac{P_i - C_i}{P_i} \right) = R_i,$$

in Ramsay pricing notation, or

$$\frac{dPS_i}{dCS_i} = \frac{\partial V}{\partial U_{P_i}} / \frac{\partial V}{\partial U_{C_i}}$$

as defined in equations (1a) and (9).

Ross (1980) explores Ramsay pricing with interdependent markets, but does not take up the more complicated cases when intervention occurs in two or more related markets on the supply side. Such cases are very important in agriculture. Consider corn and soybeans. They are produced on roughly the same type of land with similar production techniques but somewhat different factor proportions (corn using more fertilizer and pesticides). The supply of soybeans, given the price of corn, is expected to be quite elastic. Indeed econometric estimates of such supply functions have usually not produced sharp estimates of supply elasticities because corn and soybean prices are too collinear.

If intervention is to be undertaken to aid corn producers specifically (as it has been) because of the high supply elasticity we would expect to see quantity controls rather than subsidies. 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 corn and soybean producers jointly pursuing support for intervention of the subsidy type for both products simultaneously. What we actually observe is

relatively modest intervention with both subsidies and production controls (voluntary set-asides) for corn producers, but essentially an unregulated market for soybeans. There are differences between the commodities that could explain the absence of joint action, but the interesting possibility here is that it may be most efficient for soybean producers to support intervention in the corn market, with a program that does not restrict entry of soybean land into corn production. Then the owners of soybean and corn land will benefit equally if corn and soybean land are perfect substitutes.

Recent programs of land diversion have not allowed diverted land to be planted to the cash crops that provide the best alternative use. Thus, set-aside corn land cannot be planted to soybeans. This feature considerably changes the deadweight losses of a voluntary diversion program from the situation discussed earlier with reference to figure 4. Instead of a deadweight loss of $b + e$, the deadweight loss resulting from a transfer of $a + b + c$ becomes $b + e + f$ if the rental value of land in its best permitted use is P_0 . This tends to make acreage diversion a less efficient redistributive mechanism than a subsidy, even if the supply and demand elasticities are the same. Presumably the more efficient option of allowing corn producers to grow soybeans on diverted acreage is not politically viable because of opposition by soybean producers.

To compare the relative efficiencies of redistribution to producers of two related commodities jointly, the PS dimension of the surplus transformation curve should be the sum of rents received by both producer groups. The preceding discussion suggests consideration of three alternative surplus transformation curves: (1) one derived from the supply and

demand functions for "grains," a corn-soybean aggregate: (2) one derived from the demand for corn and a supply function of corn that permits the soybean market to adjust to each change in the corn price, so that the producers' surplus from this supply curve is the sum of corn and soybean producers' rents. (3) The same as (2), but derived from soybean supply and demand curves. Intervention corresponding to (1) would be a subsidy or control program for both soybean and corn producers. Intervention corresponding to (2) would be a program for corn producers that indirectly aided soybeans, i.e., on which soybean producers "rode free," and (3) a program for soybeans that indirectly aided corn. The efficient redistribution hypothesis suggests that the choice of option (2) as policy means that this program has smaller deadweight losses per dollar transferred.

Interaction between commodities has implications for the formation of 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, the efficient redistribution hypothesis predicts that coalitions will be more prevalent the more closely related are sets of commodities because the deadweight losses from intervention are reduced more by joint intervention under these circumstances. The covariance among prices is a directly observable indicator of these conditions.

Uncertainty and transitory changes. One of the salient features of agriculture is that prices are variable from year to year because of random output changes. Farm income is less variable because price and output have negative covariance, but still is quite unstable (the classical explanation for high savings rates among farmers). Agricultural asset prices, notably land prices, are much less variable. This fact, like the high savings rate, suggests that annual variations in farmers' returns are preponderantly transitory. How does efficient intervention respond to supply and demand shifts when a large component of these shifts is known to be transitory?

A large fraction of U.S. intervention in farm commodity markets has been sold under the label "stabilization." This is true not only of programs which involve stockpiling commodities, but also of interventions such as set-asides and import constraints. Proponents of these measures sometimes argue as if they increase aggregate full income, suggesting that the interventions are not completely explained as income redistribution measures. They are like Fire Departments or irrigation projects with benefits exceeding costs.

The redistributational consequences of purely stabilizing intervention are calculated in terms of expected values of producers' and consumers' surpluses. Thus, the surplus transformation curve and political preference function must be respecified. The simplest approach is to assume that political preferences and market choices are risk neutral, and replace surpluses by their expected values. This simplification does not provide a basis for a prediction that intervention will be stabilizing. Starting from market equilibrium, it is not

clear whether purely stabilizing intervention increases $E(PS)/E(CS)$ (although it is clear that $E(PS)$ and $E(CS)$ will change in opposite directions). Whether producers or consumers gain depends not on the elasticities of supply and demand at market equilibrium but on the form of the supply and demand functions. For example, the change from a linear to a log-linear demand function reverses the result. In addition, the form of the disturbances (additive versus multiplicative) makes an important difference.^{13/} Attaining sharp estimates of elasticities is difficult enough. My prior belief is that it is hopeless to obtain reasonable confidence about any particular functional form or form of the disturbances for agricultural supply and demand functions. Moreover, the dependence of qualitative results on parameters of only secondary importance for most purposes suggests that the quantities redistributed must be small. Therefore, no tests of hypotheses about redistribution due to stockpiling/stabilization programs will be undertaken.

The difficulty of detecting permanent change in the presence of substantial transitory noise is likely to cause adjustment lags which make a difference in estimated supply and demand elasticities and hence in surplus transformation possibilities. For example, it could be that after a group of commodity producers has invested heavily in fixed equipment (say, after a war), supply becomes more inelastic. Producers would be particularly worried about price declines which would transfer a large sum of quasi-rents to consumers. So we have a short-term surplus transformation curve quite different from the long-term curve.

Also, the existence of transitory output changes or demand shifts (notably from the export market) brings in the possibility of intervention by insuring producers against market prices below mean price. This insurance can be provided by government commodity storage or production adjustment. For example, in March of 1978 wheat price prospects were judged by the government to be too low on the evidence of winter wheat acreage planted the preceding fall and the progress of its growth as of March. Consequently, a program was put into place by which producers received payments to graze cattle on the still immature wheat. With this kind of program one can reduce market-induced redistribution to consumers along a short-term surplus transformation curve while leaving the options open for producer gains if the market outcome is favorable to them.

In terms of the efficient redistribution hypothesis, the relevant issue is the expectation of deadweight loss per dollar transferred under alternative programs. Consider the following simple model of the market for a storable crop. Production for year t is a function of expected product price, but is subject to random variation after input decisions are made:

$$(31) \quad X_t = X(P_t^*, u_t).$$

Year t begins when the crop is harvested and ends the day before the next crop is harvested.

P_t^* is observed, and the corresponding production decisions made, during year $t-1$, after which u_t is observed. This leads to a recursive rather than simultaneous supply-demand equilibrium. At the beginning of year t , output is a random variable unresponsive to price in year t . P_t is determined by the demand for current consumption

(including exports) and the demand for stocks to be carried into the following year:

$$(32) \quad P_t = D(Q_t + I_t)$$

The equilibrium condition for carryover stocks is

$$(33) \quad P_{t+1}^* = P_t + C(I_t), \quad I_t > 0$$

$$P_{t+1}^* < P_t + C(I_t), \quad I_t = 0$$

where $C(I_t)$ is the marginal cost of storage (including interest).

The supply available each year is the exogenous (at beginning of t) random variable

$$(34) \quad S_t = X_t + I_{t-1}$$

and the market-clearing condition is

$$(35) \quad S_t = Q_t + I_t$$

Substituting (35) in (32), we have each year's price as function of S_t with $\% \Delta P_t / \% \Delta S_t$ the inverse of the total (consumption plus stocks) demand elasticity.

Purely stabilizing intervention would involve governmental acquisition and sale of stocks. Apart from increased production by risk-averse farmers and second-order effects due to functional form (e.g., average total revenue is increased by stabilization if demand is linear), the mean values of X_t and P_t (and P_t^*) are unchanged. When the stabilizing storage consists of subsidies paid to farmers as storage payments, as under the Farmer-Owned Reserve program from 1977 to the present, rents to stockpilers are created if $C(I_t)$ is not perfectly elastic. But otherwise there is no income redistribution.

Programs that put a floor under price without stock accumulation, such as the current target-price/deficiency-payment schemes for wheat, corn, barley, sorghum, rice, and cotton, are equivalent to a production subsidy. Programs that attempt contingent production adjustment, such as the wheat-grazing program, are equivalent to production

controls. But their effects are harder to measure. It is no longer correct to say that a price support has no effect if market price is below the support price. The expected redistribution before u_t is observed is the appropriate basis for calculating surplus transfers.

The elasticities relevant to the efficiency of these transfers are derived from (31) and (32). These are short-run elasticities in the sense that they refer to adjustments made from one crop year to the next responding to prices or price expectations which are expected to be different next year. Long-run elasticities -- such as the response of X_t to an increase in the mean value of P_t^* expected to be maintained -- are relevant to intervention that changes mean price or output over an indefinite number of years.

The empirical implications are as follows. An inelastic short-run total (including stocks) demand elasticity promotes the efficiency of contingent production controls such as the wheat grazing program. An inelastic short-run supply elasticity promotes the use of contingent subsidies such as deficiency payment based on target prices near the mean price level. An inelastic long-run demand elasticity promotes the use of permanent production controls such as limitations on entry or fixed acreage or production bases as were once applied to wheat, rice, tobacco, and milk. An inelastic long-run supply curve promotes the use of noncontingent subsidies such as "conservation" payments or low interest rates on loans to buy land.

"Short-run" does not refer to weekly or monthly changes within a crop year, but to year-to-year changes. Thus, the short-run and long-run distinction corresponds to that lying beyond partial adjustment or

adaptive expectations models such as in Nerlove (1958). This suggests trying lagged-dependent-variable supply and demand curves to obtain estimates of the required long-run/short-run differences in elasticities.

The overall likelihood of intervention of the contingent type increases as $\min(\epsilon, \eta)$ for the short run increases. The amount redistributed increases as the year-to-year variability of random supply or demand deviations increases. Both small elasticities and large deviations result in greater price variability. Therefore, we expect greater year-to-year price variability in the absence of programs to be associated with more redistribution, not because of public-good aspects of stabilization, but because variability is symptomatic of conditions that indicate a low deadweight loss per dollar transferred.

What Is Clout?

The discussion so far has considered determinants of intervention only from the point of view of surplus transformation possibilities. The predictions about intervention assumed stable, and in some cases homothetic political preferences. But it appears obvious that some groups of commodity producers and factor owners have more political power than others, and that many are able to extract income from consumers or taxpayers through political action. What groups should be expected to have the most political power, and can circumstances be forecast under which political preferences would change?

Rausser and Freebairn have an argument in their policy preference function that represents the preferences of policymakers themselves, although it plays only a peripheral role in their empirical work. According to the efficient redistribution hypothesis, the preferences of politicians or bureaucrats make a negligible difference. Policymakers are essentially middlemen, performing redistributive services demanded by organized groups of voters (interest groups) in a competitive political setting that precludes their earning monopoly rents from their constitutional powers, or establishing programs other than those revealed to be the best attainable approximations to the voters' preference. The politicians' own preferences make no more difference than the preferences of waiters about the food that a restaurant's customers order, capitalists' views about their products, or farmers' opinions about growing crops. In all these cases the preferences do make a difference, in who engages in what activities and for what remuneration. But we usually feel safe in explaining and forecasting events in the commodity markets without reference to the preferences of the industry's labor force, suppliers of funds, or managers. According to the efficient redistribution view, we ought to take the same approach to political events.

Instead of policymakers' preferences, we introduce variables in the political preference function which measure pressure brought to bear by interest groups. Shifts in the political preference function result from investment by these groups. Following Becker (1980), assume there exists a stable production function for political support that generates political pressure. A group of commodity producers can open a Washington office, inform members of developments affecting them, get out the vote, and so forth. Such activities are collective investment analogous

to purchases of farm machinery by individual producers. The nature of the investment project is analogous to some depictions of advertising--it is an attempt to change the marginal rate of political substitution between producers' and consumers' incomes so that producers' income has a higher marginal political value at all points on the transformation surface, and hence to generate a political equilibrium more favorable to producers. Investment should continue up to the point where the marginal discounted expected gain in producers' income equals the marginal cost of investment, which is the opportunity return in ordinary business investment (which in equilibrium is the appropriate market rate).

The damper on redistribution imposed by deadweight losses has already been discussed, and implications in terms of supply and demand elasticities have been derived. What has not been discussed is the costs of making political investments by an interest group. Stigler, Posner, Peltzman, and Becker provide reasons for expecting economies of scale to be important in weakening very small interest groups and diseconomies of size to weaken very large groups. Over the range of sizes of farm commodity groups--from about 15,000 sugar producers (less than 1/20 of 1 percent of the U.S. voting population) to 1 million corn producers (about 2 percent of the U.S. voting population)--I can't find any guidance in theory developed to date as to which groups are most favored by size considerations.

Consider changes from an (arbitrarily arrived at) initial political preference function. The assumption of diminishing marginal political preference implies that when market conditions change the distribution of surpluses, this will tend to reduce the political power of interest groups which gain, and increase the political power of groups that

lose. However, it is often not clear from knowledge of supply and demand shifts whether producers or consumers gain, as shown earlier. When demand or supply increases, in the linear case it was shown that a homothetic family of surplus transformation curves results. This leads to unchanged intervention if political preferences are also homothetic, but perhaps changes in surpluses create forces that change political preferences? Suppose that due to a random price increase, producers have increased wealth, some of which they will invest. If the nonfarm capital markets will absorb the investment at the going rate of interest, then there is no reason to expect change in farm investment. But empirical studies indicate that farmers do spend more on capital investment following income increases. Presumably this reflects not so much imperfections of the capital markets as the fact that increased demand or lower costs increases the rate of return to investment in agriculture given the old capital stock. Does the rate of return to political investment also increase? Yes, because a given change in slope dPS/dCS generates a bigger gain in producers' surplus on the expanded surplus transformation curve.

However, it is also the case that consumers see a bigger return to political investment in opposing pro-producer intervention. I don't see how either side can be presumed to gain political advantage in equilibrium. Therefore, I continue to assume the independence of political preferences from changes in the constraining opportunity set, and maintain the prediction that an increase in demand or reduction in costs leads to no predictable tendency for change in the extent of intervention.

A problem much discussed in the literature is that political investment involves external benefits that create free-rider problems that may preclude effective action. In addition, the costs of becoming organized may be a serious impediment, and so may disharmony of interests, such as results from widely varying costs of production. It seems likely that disharmony of interests has scuttled many political investment projects. On the other hand, Posner (1974) and Stigler (1974) argue that asymmetry among firms lessens the free rider problem and increases the participation of firms in the coalition seeking intervention. However, in U.S. agricultural policy there are instances where failure of a commodity group to reach a unified position is helpful in explaining why some interventions were not undertaken or were unsuccessful in being maintained despite relatively small deadweight losses per dollar transferred. Examples are the 1973 Act's payment to wheat allotment holders and the disagreement among cotton interests that resulted in an ineffective market support price in the 1977 Act.

Problems of organizational costs and free riders may not be as important in explaining farm commodity programs as in other political redistribution. Proposals for intervention and estimates of their effects are provided by economists in USDA and the agricultural colleges. When producers' costs are about the same, they all are led to see the desired political outcome in close to the same way. The only organization required is an information network, which has long existed in the USDA's extension service and ASCS offices, publications and meetings of farm organizations, and farm magazines and radio shows. The USDA and University personnel educate producers on gains from alternative programs and farm organizations inform

producers which competitors for office are on their side. For these reasons, and because size of market has no predictable implications from the surplus-transformation side, numbers of producers may not be an important variable in explaining intervention on many agricultural markets.

It seems likely, though, that more complex organizational efforts are needed in mitigating opposition to pro-producer intervention, or opposing anti-producer intervention. There is evidence of the latter activity by producers of tobacco, milk, and eggs. Here numbers and free riders may be more important.

We can introduce, as variables explaining the degree of intervention, data pertaining to costs of organizing and harmony of interests among producers. Such variables are geographical concentration of producers and stability of the industry's structure over time. I think that these variables are likely to be important not so much because they make organization cheaper or help reduce free-rider problems, but rather because if production is widely dispersed among different types of farms and areas of the country, it seems more likely that significant differences in costs and hence disharmony of interests occurs. For the same reason, the stability of geographical production patterns and techniques of production may be important in promoting intervention.

Stigler (1971) emphasized that political preferences for intervention may be importantly influenced by inter-commodity relationships. As mentioned earlier, increasing the price of corn will tend to benefit soybean producers. Therefore, we predict that soybean producers will support intervention to aid the corn growers. At the least, opposition is mitigated in such cases. On the other hand, intervention in the

corn market will reduce rents in the livestock industry. Even if cattle feeding is a constant-cost activity, a rise in corn price generates a fall in the price of feeder calves. In the long run, supporting the corn price increases the rents to Corn Belt cropland and reduces rents to Western rangelands. The result could be more opposition to intervention in feed crops than in food or fiber crops. However, one needs to know that ranchers are a politically more effective opposition group than final consumers of food.

Political preferences also may be sensitive to the integration of middlemen with the consumers. Since farm products are usually not finished consumer goods, "consumers' surplus" includes rents to middlemen's resources which are not perfectly elastic in supply to the food industry. For example, it is said that one reason Secretary Bergland was sympathetic to protecting the domestic sugar industry was that he and other farmers in his upper Minnesota area were members of a cooperative which owned several local sugar beet processing plants. While beets are quite elastic in supply, so that beet growers would not lose substantially with free trade in sugar, the processing plants had no good alternative use. Interests of processors of competing products also can influence the form of regulation. On the sugar issue again, the manufacturers of high-fructose corn syrup favored import restrictions on foreign sugar but opposed direct payments to sugar producers when these were proposed (and implemented) in 1977. The general question remains whether inclusion of middlemen among consumers strengthens or weakens their political power.

Issues of coalition formation and free riders may also be important in determining the form of intervention. For example, if producers of a crop differ in costs of production, a voluntary

diversion program may be attractive. As another example, opposition to a production-control program may differ from opposition to a subsidy program, because the former is paid for by consumers of the commodity and the latter by taxpayers. How this works out politically depends on the income elasticity of demand for the good, the size distribution of income, and the political power of different income groups.

In summary, I expect more intervention in favor of producers the more homogeneous they are in terms of rents received per unit of output and the lower the costs of organization. Proxy variables for one or both that should be associated with greater intervention are: (i) greater geographical concentration of producers, (ii) greater geographical stability of production, (iii) smaller share of the commodity used as livestock feed, and (iv) larger shares of the final product price accounted for by farm products (the "farmer's share of the food dollar"). The latter two predictions depend on consumers being a weaker opposition group than livestock producers or food processors, respectively. The number of producers may play a role, but the sign of the effect is not clear.

Generally, the earlier predictions based on the deadweight loss from transfers as a function supply and demand elasticities, the importance of exports, and the results of shifts in supply or demand, are more directly related to the hypothesis of efficient redistribution. That is, there are probably several plausible reasons why geographical concentration might lead to greater intervention, but it is hard to see any reason except efficiency in redistribution to predict relatively low supply elasticities to be associated with subsidies and high supply elasticities to be associated with production controls.

Alternatives to Efficient Redistribution

Views have been expressed about governmental intervention in agriculture which may be taken as competing hypotheses to all or part of the efficient redistribution view. For example, Anderson (1978), hypothesizes that "covert" policies that do not involve explicit governmental outlays (like production controls) will be chosen over policies that do (such as government commodity purchases), while efficient redistribution indicates that the policy is chosen that minimizes deadweight loss per dollar transferred.

There is a large amount of writing about agricultural policy by ex-politicians and professionals involved with farm policy. It consists of generally unsystematic observations and conclusions, but they are usually well considered judgments of reasonably knowledgeable people. They should be a useful source of alternative hypotheses at the least.

It is striking how little of this "expert testimony" appears to contain the germ of, or even to be consistent with, the efficient redistribution view. Generally, there is a feeling that the determinants of farm policy are complex, so complex that economists are unlikely to have anything useful to say about them. Moreover, much of the writing on policy by agricultural economists contains the idea that the fundamental reasons for farm policy involve correcting social problems. There is a "farm problem," which may be described as chronically low income in agriculture, immobility of farm resources, instability, or excessive market power of middlemen. The social value of farm policy, and the reason it exists, is to provide a remedy to these problems through collective action. (See, Ruttan, Brandow, Cochrane and Ryan,

Tweeten, or Halcrow). This view can be expressed so as to sound a lot like the efficient redistribution hypothesis. But there are important differences. The main feature of the problem-solving view that distinguishes it from the discussion in the preceding section is a presumption that intervention in some broad sense improves efficiency. It expands the surplus transformation frontier, so that even though farm politics may be a redistributive game, it is a positive-sum game in aggregate full income.

In contrast to this position, writings by political scientists and some economists put forth a "political muscle" view, according to which farm policy is basically a matter of interest-group organization and power (Talbot and Hadwiger, Hardin, Barton). Some have agreed that farm policy was socially productive in the 1930's but created politically powerful coalitions that maintained intervention after its ratio of benefits/costs became negative in later years (e.g., Paarlberg). While political scientists have written primarily as neutral observers of political processes, economists holding the political muscle view have been primarily interested not in a positive theory of political action but in rebutting the problem-solving view, particularly industry-sponsored versions of it such as Elkin (1980) or National Soybean Processors Association (1976). They devote their main efforts to the results of intervention, denying the existence of gains in aggregate income and attempting to measure the deadweight losses or redistribution to the already well off. (see, for example, Wallace, P. Johnson, D.G. Johnson (1973, 1974), Hushak, Gardner and Hoover, or Ippolito and Masson.) However, the anti-intervention economists have virtually nothing to offer as a theory of political muscle and so are useless for present purposes.

In the pro-intervention writings one sees statements such as the following: "The Congress of the United States reaffirmed year after year the need for price and income programs to protect and support farm incomes. This it did after reviewing the consequences of the programs each year and evaluating the costs." (Cochrane and Ryan, 1976, p. 391). While one may be suspicious of a normative defense of farm programs along these lines, as a positive statement it has force. It invites us to take seriously the idea of explaining governmental intervention on the presumption that the government is making informed and rational choices.

Indeed, there are helpful hints in the saying of the political scientists and the tendentious economists of both the pro- and anti-intervention persuasions. The problem-solving view of policy is rooted in such facts as the relationship of New Deal farm programs to economic hardship of farmers in the Great Depression. The anti-interventionists focus our attention on the redistributational core of policy. From the literature by political scientists, it is helpful to see, for example, how the passage of the Agricultural and Consumer Protection Act of 1973 was abetted in the House by a coalition of farm-district and urban Representatives interested in food stamps (Barton). Specific instances like these are suggestive of more general hypotheses.

The main general element that anecdotal expert testimony adds to the theoretical framework discussed earlier is emphasis on uncertainty and inertia in political equilibrium. Political clout is a durable product of investment, and as

such is best thought of as a capital stock concept.

The capital formation process and the resulting flow of changes in political preferences are both uncertain. Groups may invest for years and earn no returns (although it is always possible to argue that even worse outcomes have been prevented). Programs, once established, sometimes seem to have a life of their own, such as the Agricultural Conservation Program which continues to pay a few hundred million dollars per year to farmers even though there seems to be little if any active lobbying for it and six consecutive Presidents have recommended its elimination in their budgets. Other programs shift gears quite rapidly, such as in the spring of 1978 when the American Agriculture Movement, with expenditures probably in the hundreds of thousands of dollars, succeeded in obtaining benefits in the Emergency Agricultural Act of 1978 that may have amounted to \$2 billion or so. In the case of the New Deal's AAA, it seems likely that permanently lower costs of organization by farmers were attained by the establishment of a farmer representative system in the AAA extending down to farmer-elected county committeemen. USDA employment expanded from 30,000 in 1930 to 100,000 in 1940, with about an equal number of state and county committeemen (Hardin 1967, pp. 9-12). The basic organization created in the 1930s continues to the present day.

In summary, what this discussion adds to the earlier more formal treatment of intervention is an emphasis on the importance of attention to the time pattern of market and political events, an appreciation of the likelihood of a substantial residual of unexplained intervention, and the need for stock-concept variables that permit past events to influence the present.

Concluding Overview

A premise of this paper is that extension of ad hoc reflections on the policy process such as contained in Gardner (1979) or others cited earlier is not likely to be a profitable research program for developing and testing hypotheses to explain governmental intervention in agriculture. What is lacking is a general framework in which to incorporate the hypotheses, and assess their relative merits empirically.

The weakness of our current state of knowledge is most apparent when economic or political experts, as they often do, venture predictions about the future of agricultural policy. Some say that future policy will react to future problems that develop, e.g., that future Soviet production short-falls, or worldwide excess demand for grains, will lead to continuing intervention in the U.S. grain export business (Schnittker 1980). Some expect that the declining number of farmers will (at last) lead to a diminution of their political power and to a reduction in intervention. Others point to the potential for coalition building to stay this outcome (Kramer 1979). But there is no good way to assess competing predictions ex ante. There is no accepted theory to suggest that particular forecasts are plausible or implausible. And the lack of a general explanatory framework makes it difficult to learn from erroneous forecasts.

The reason for the lack of a general theory is probably that the hypotheses generated by the reflections of policy participants and day-to-day observers are too disparate. They point in too many directions. In this situation, one needs a more restricted framework in which to organize the facts. The efficient redistribution hypothesis is such a theory. It judges the plausibility of suggested explanations of

intervention by asking how the proposed explanatory factors affect either political preferences or the opportunity set for redistribution. If such effects are absent or one has to strain to make them plausible, the theory suggests the poverty of the proposed explanation. If an explanatory factor is vague, the theory may suggest what must be done to sharpen it.

Consider the idea that milk producers have achieved political results favorable to them because they have acquired "clout." This means: they get what they want. The role of theory is to suggest factors to explain why milk producers achieve results while others do not. From the earlier discussion, we look on the political preference side for reasons why the dairymen were effective in organizing, making their well-being politically valued, and mitigating opposition. Theory suggests looking at interests of related commodity producers, geographical concentration, similarity of costs, stability of the industry. On the opportunity-constraint side, we look for the potential of redistribution with relatively small deadweight losses, which we know to be related to supply and demand elasticities, the importance of exports, and to be sensitive to the type of intervention undertaken. Moreover, theory suggests quite specifically how supply and demand elasticities, and some other characteristics of commodity markets, should influence intervention, if the efficient redistribution hypothesis holds.

A subsequent paper will report the results of research in progress with the broad goal of obtaining better understanding of the reasons for the history of governmental intervention in U.S. agriculture, and the narrower goal of testing the efficient redistribution hypothesis.

Footnotes

1. To show that the sum of surpluses is maximized at E, differentiate the sum of (5) and (6) with respect to Q and equate the derivatives to zero. Solving for the maximum in the linear case, $Q^* = (a-c)/(d-b)$. Equating (3) and (4) to find market equilibrium, $Q_e = (a-c)/(d-b)$. Thus, $Q^* = Q_e$. In the general case, the first-order condition for a maximum $CS + PS$ is $D(Q) = S(Q)$, which is also the market equilibrium condition.

To show that the slope of (7) at E is -1, differentiate (7) with respect to CS, substitute for \hat{Q} from equation (5), and equate to -1. This yields $\hat{Q} = (a-c)/(d-b)$. Thus, Q_e is the value of \hat{Q} where the slope of (7) is -1.

3. For "monopoly," we maximize producers' surplus to find $Q_m = (a-c)/(d-2b)$. This yields

$$\gamma = -\frac{d}{b} + 2 + \frac{d}{b} - 2 = \underline{0}$$

In the general (nonlinear) case, differentiate the general forms of (5) and (6) with respect to Q and divide to obtain:

$$(F-1) \quad \gamma = \frac{D'(Q)Q + D(Q) - S(Q)}{-D'(Q)Q}$$

At competitive equilibrium $D(Q) = S(Q)$, so $\gamma = -1$. At the monopoly output, supply price equals marginal revenue, $d(D(Q)Q)/dQ$, which is $D'(Q)Q + D(Q)$. Therefore, the numerator is zero and $\gamma = 0$.

4. The constant-elasticity inverse demand and supply curves are:

$$P_d = A Q^n \quad \text{and} \quad P_s = B Q^e$$

where n and e are the inverse elasticities of demand and supply. The indefinite integrals for consumers' and producers' surpluses under production controls are

$$(F-2) \quad CS = -\frac{n}{n+1} A Q^{n+1} dQ + C_1$$

$$(F-3) \quad PS = A Q^{n+1} - \frac{1}{e+1} B Q^{e+1} dQ + C_2$$

The changes in CS and PS when Q is controlled are:

$$\frac{dCS}{dQ} = -n A \hat{Q}^n$$

$$\frac{dPS}{dQ} = (n+1) A \hat{Q}^n - B \hat{Q}^e$$

The slope of the surplus transformation curve for given \hat{Q} is

$$\begin{aligned} (F-4) \quad \frac{dPS}{dCS} &= \frac{(n+1) A \hat{Q}^n - B \hat{Q}^e}{-n A \hat{Q}^n} \\ &= \frac{(n+1) P_d - P_s}{n P_s} \quad (P_d \text{ and } P_s \text{ are demand and supply prices at } \hat{Q}) \\ &= -\frac{1}{n} \left(1 - \frac{P_s}{P_d} \right) - 1 \end{aligned}$$

To express this in terms of \hat{Q} , note that at equilibrium

$$A Q_0^n = B Q_0^e$$

$$Q_0 = (B/A)^{\frac{1}{n-e}} \quad \text{and} \quad B/A = Q_0^{n-e}$$

Dividing equation (F-4) by A

$$\begin{aligned}
 (F-5) \quad \frac{dPS}{dCS} &= \frac{(n+1)\hat{Q}^n - B/A \hat{Q}^e}{-n\hat{Q}^n} \\
 &= \frac{(n+1)\hat{Q}^n - Q_0^{n-e} \hat{Q}^e}{-n\hat{Q}^n} \\
 &= \frac{n+1 - Q_0^{n-e} \hat{Q}^{e-n}}{-n} \\
 &= -\frac{1}{n} \left(1 - \frac{\hat{Q}^{e-n}}{Q_0} \right) - 1
 \end{aligned}$$

In terms of elasticities of demand and supply as usually expressed, we have $\eta = 1/n$ and $\epsilon = 1/e$,

$$(F-6) \quad \frac{dPS}{dCS} = -\eta \left(1 - (\hat{Q}/Q_0)^{\frac{1}{\epsilon} - \frac{1}{\eta}} \right) - 1$$

5. The effects of a change in slope in the linear case are derived as follows: A change in d in equation (4) changes the slope, but also shifts the supply curve to a new market equilibrium. In order to study a change in slope that keeps the market equilibrium unchanged, it is necessary to adjust c at the same time d is changed. We have $Q_e = (a-b)/(d-b)$ and wish to change \underline{d} and c in such a way as to leave Q_e unchanged:

$$dQ_e = \frac{(a-c)d\underline{d} + (d-b)dc}{(d-b)^2} = 0$$

Solving for dc ,

$$dc = -\left(\frac{a-c}{a-b}\right)d\underline{d} = -Q_e d\underline{d}$$

The appropriate change in γ , from equation (8), is

$$(F-7) \quad \frac{d\gamma}{d\underline{d}} - Q_e \frac{d\gamma}{dc} = \frac{1}{b} - \frac{Q_e}{bQ}$$

For $\hat{Q} < Q_e$, the second term is larger in absolute value, and the change in (F-7) is positive ($b < 0$). For $\hat{Q} = Q_e$ the change in slope is zero. This is because the slope is always -1 at the competitive equilibrium. Note that this also holds for text equation (9).

Since a positive dy means the slope of the surplus transformation curve is moving toward zero, the preceding results mean that the less the slope of the (ordinary) supply function-- d being the slope of the inverse supply function--the less producers' surplus is obtainable per dollar of consumers' surplus sacrificed.

It is not obvious that a change in elasticity of supply will make a large difference in redistribution. Note from (F-7) that the γ is more sensitive to a change in supply elasticity the smaller is $|b|$, i.e., the more elastic the demand function. Indeed, if demand and supply are both very elastic, it will be technically impossible to redistribute much income from consumers to producers by means of output controls.

Note that in the example shown for $d \rightarrow \infty$ (perfectly inelastic supply) in figure 1, it is impossible to redistribute much income to producers because the elasticity of demand is only a little less than 1. For elastic demand curves at E, producers' surplus is necessarily reduced by output control when supply is fixed. Fixed supply often generates corner solutions at E. (The slope of the transformation curve is not -1 at E when $d \rightarrow \infty$.) Generally, there will be corners in the surplus transformation curve if output restriction causes supply price to go to zero.

To consider the effect of the slope of the demand curve more fully, we can study what happens to equation (8) when the demand slope b changes, again

accompanied by a change in a sufficient to maintain market equilibrium at Q_e .

$$(F-8) \quad \frac{d\gamma}{db} + \frac{d\gamma}{da} = \frac{(a-c) + bQ_e - d\hat{Q}}{b^2\hat{Q}}$$

When $\hat{Q} = Q_e$, the change in γ is zero. When $\hat{Q} < Q_e$, the negative terms in the numerator are larger than the positive terms, making (F-8) negative. This means that an increase in the elasticity of demand increases γ , that is, discourages income redistribution to producers.

6. Using the same approach as in footnote 4,

$$\begin{aligned} \frac{dPS}{dCS} &= \frac{eB\hat{Q}^e}{AQ^n - (1+e)B\hat{Q}^e} \\ &= \frac{e\hat{Q}^e}{Q_0^{e-n} \hat{Q}^n - (1+e)\hat{Q}^e} \\ &= \frac{e}{(Q_0/\hat{Q})^{e-n} - 1 - e} \\ &= \frac{1}{\frac{1}{e} (Q_0/\hat{Q})^{e-n} - \frac{1}{e} - 1} \end{aligned}$$

In terms of elasticities as usually defined,

$$\frac{dPS}{dCS} = \frac{1}{\varepsilon(Q_0/\hat{Q})^{\frac{1}{e}-1} - \varepsilon - 1}$$

7. The amount of taxes that must be raised to pay the subsidy is

$$T = (P_s(\hat{Q}) - P_d(\hat{Q}))\hat{Q}$$

When the subsidy is increased, the amount that is recycled to consumers is (terms defined in footnote 4):

$$\frac{dCS/dQ}{dT/dQ} = \frac{-nA\hat{Q}^n}{-(n+1)A\hat{Q}^n + (e+1)B\hat{Q}^e}$$

$$\frac{dCS}{dT} = \frac{1}{\frac{1}{n}(n+1) - (e+1)(Q_0/\hat{Q})^{n-e}}.$$

Converting to elasticity notation we get the denominator in equation (16a). The change in external deadweight loss (D) per dollar transferred (M) is

$$\tau = \frac{dD}{dM} = \frac{dD}{dT} \cdot \frac{dT}{dM} = D' \frac{dT}{dM}.$$

Since the change in transfers is the change in taxes minus the amount recycled to consumers in the form of lower prices, we have

$$\frac{dM}{dT} = 1 - \frac{dCS}{dT}.$$

Therefore,

$$\tau = D' \left(\frac{1}{1 - \frac{dCS}{dT}} \right).$$

9. This result differs from the results of Cox (1980) for deadweight loss, in which the elasticities enter symmetrically. His equation for (marginal) deadweight loss from a price control is

$$D = (\tilde{P} - \tilde{P}^*) \left(\frac{\epsilon}{\eta} - 1 \right)$$

where \tilde{P} is the controlled rate of price rise and \tilde{P}^* is the unrestricted rate of price rise. The static analog, using the notation of footnote 4, is

$$(F6a) \quad D = (P_s - P_e) \left(\frac{\epsilon}{\eta} - 1 \right).$$

My analogous formula is the reciprocal of the result in footnote 3 (to obtain redistribution from producers to consumers from a price ceiling), plus 1, because $dCS = dPS + dD$. This is

$$\frac{dD}{dPS} = \epsilon \left((Q_0/\hat{Q})^{\frac{1}{e}} - \frac{1}{\eta} - 1 \right),$$

and can be expressed in terms of prices as

$$(F6b) \frac{dD}{dPS} = \epsilon(P_d/P_s - 1).$$

Equations F6a and F6b are very different, as can be seen by a simple example. If $\eta = -1$, $\epsilon = .25$, with $P_e = 1$, $P_s = .6$ and $P_d = 1.1$ then F6a is $-.4(-1.25) = .50$. But F6b is $.25(0.83) = .21$.

Cox's formula gives the marginal deadweight loss from a change in \hat{Q} , that is, $dD/d\hat{Q}$ (which is just $P_d - P_s$) while mine gives the marginal deadweight loss per dollar redistributed from producers, dD/dPS . The latter is the appropriate measure for looking at price controls as a redistributive issue. Equation F6a leads one astray in predicting, for example, that the marginal deadweight loss at a given output is the same if $\eta = -.5$ and $\epsilon = 1$ or if $\eta = -1$ and $\epsilon = .5$. The change in deadweight loss from a given change in \hat{P} or \hat{Q} is the same, but the change in deadweight loss per dollar transferred is quite different in the two cases.

10. Derivation of this result: To confirm that maintaining $\hat{Q} = kQ_e$ while \underline{a} changes keeps PS/CS constant, differentiate equation (10) with respect to \underline{a} :

$$\hat{Q} = kQ_e = \frac{k(a-c)}{d-b}$$

$$\frac{d\hat{Q}}{da} = \frac{k}{d-b}$$

The derivative of (10) is

$$\frac{d(PS/CS)}{da} = \frac{2(a-c)}{b\hat{Q}^2(d-b)/k} - \frac{2}{b\hat{Q}} = \frac{2(a-c)}{b\hat{Q}k \frac{(a-c)(d-b)}{d-b}} - \frac{2}{b\hat{Q}} = 0$$

Therefore, PS/CS is unchanged.

To calculate the corresponding change in the slope of the surplus transformation curve, differentiate equation (8) with respect to \underline{a} in the same way:

$$\frac{dy}{da} = \frac{(a-c)}{bQ^2 (d-b)/k} - \frac{1}{bQ} = 0$$

Therefore, the slope of the surplus transformation curve is unchanged at the same time as we maintain a constant ratio PS/CS.

11. Export restraints could benefit both U.S. consumers and producers if export demand were less elastic than domestic demand. This is quite implausible in general, but it is worth noting that in the case of the Soviet grain production shortfall in 1975 (less so in 1979) it was thought by some that the Soviet demand function for U.S. grain was very inelastic.

12. Actually, since farm products are raw materials in food and fiber production, "consumers'" surplus for these commodities also includes rents received by owners of nonagricultural goods and services used in food production. However, these marketing services may be close enough to perfectly elastic in supply that the rent component of farm-level consumers' surplus is negligible. And if the elasticity of substitution between marketing inputs and raw agricultural products is close to zero, then the area under the derived demand curve for farm products should be a good approximation of consumers' surplus in the final product market.

13. On these points, see Wright (1979).

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