Working Paper Series

Working Paper No. 437

THE WELFARE ECONOMICS OF REGULATION IN REVENUE-SUPPORTED INDUSTRIES

by

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BERKELEY

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

University of California

DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA

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March 1987

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Government regulations aimed at furthering social goals such as improved environmental quality, more equitable income distribution, etc., often reduce productivity. Policy evaluation procedures typically treat impacts on the relevant social goals as separable from impacts on the performance of the product markets affected (as is done in cost-benefit analysis, for example, or in the derivation of trade-off relations). When the affected industries appear to be competitive, traditional welfare analysis (that is, calculation of producers' and consumers' surpluses assuming competitive market clearing) is generally used to assess these impacts on product markets. However, analyses based on blanket application of the competitive model may be quite misleading; even in seemingly competitive industries, prior government intervention may influence market clearing and hence the impacts of new regulations. Accurate assessment of product market impacts thus requires that welfare analytic procedures be modified to incorporate such prior intervention.

Consider the case of pesticide regulation. Regulatory agencies typically assess the health and environmental impacts of, say, a pesticide ban separately from any impacts on agricultural product markets. Even though agriculture appears to fit the competitive model quite closely, for many commodities, producers' revenues are supported by programs such as price supports, marketing orders, and import quotas which should be taken into account in evaluating the product market impacts of the ban.

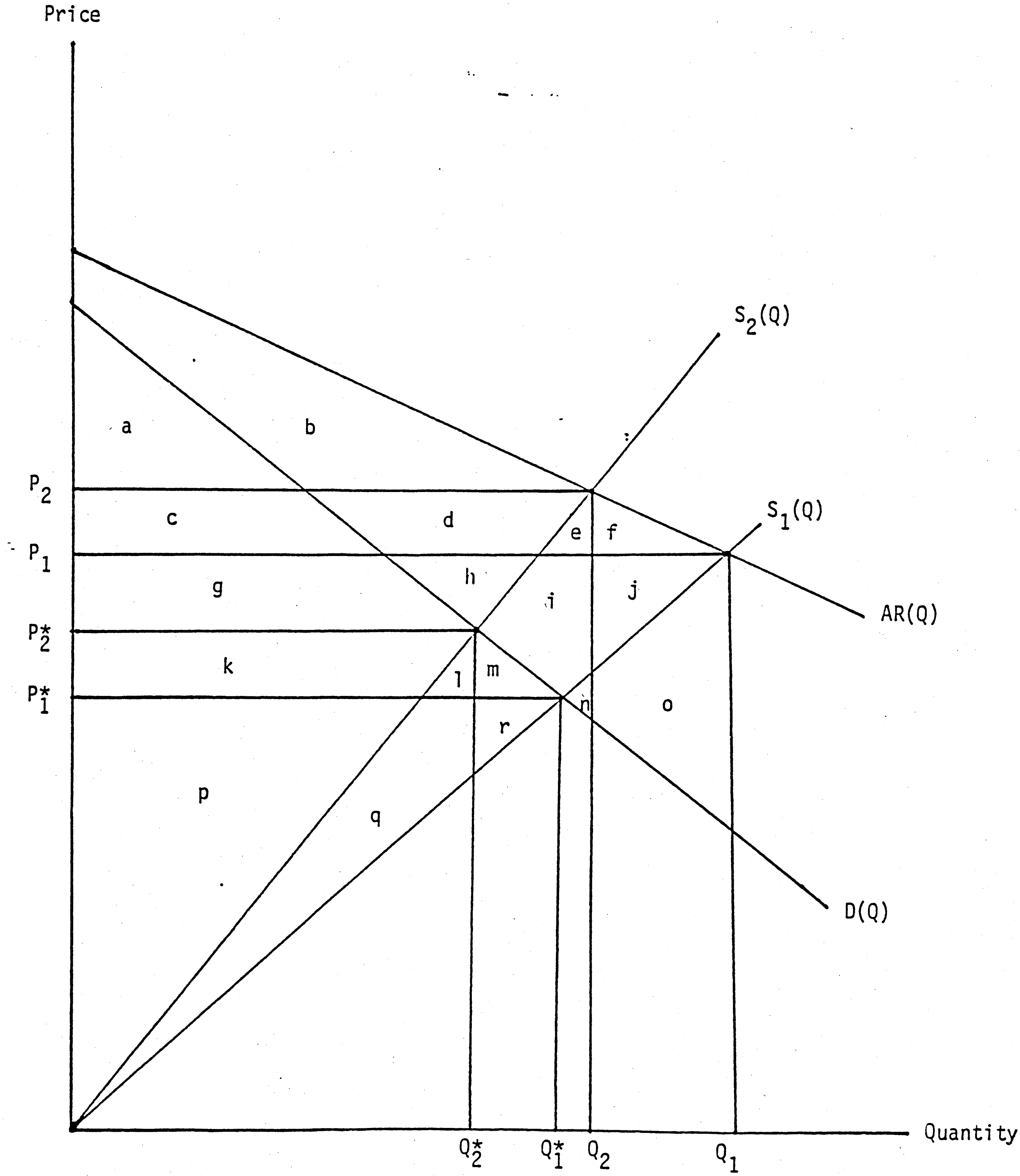
This paper examines the welfare effects of regulation on product markets affected by revenue-support programs. Section I introduces the proper welfare measures for these industries and examines the market impacts of new regulations. The analysis indicates that the distribution of effects between producers and consumers may be reversed qualitatively from the competitive equilibrium case and that the net market effect may, under some plausible conditions, be nonnegative. In Section II, the framework is applied to regulation affecting agricultural products subject to the current form of price supports. It is shown that the savings in the U. S. Treasury costs associated with regulation-induced reductions in output may be sufficiently large to outweigh consumers' and producers' losses. In any case, the use of the competitive model instead of the correct specification will produce biased estimates of the product market welfare effects of regulation, in particular, overestimates of the net market welfare effect. An empirical example comparing the impact of production restrictions on the five major crops covered by price supports shows that this bias in measuring the net market welfare effect may be as large as 50 percent of the true value.

I. Welfare Evaluation in Revenue-Supported Industries

Mechanisms such as price supports, import quotas, marketing orders, etc., are used in a number of important industries--notably, those with low elasticities of demand, like agriculture--to support producers' incomes, especially as output increases. These policies create situations such as that shown in Figure 1, where the effective price received by producers, given by the average revenue curve, AR(Q), exceeds (inverse) consumer demand, D(Q), and where the gap between average revenue and demand widens as output rises. This gap between the average revenue received by producers and consumer demand arises either from explicit government subsidies or from government policies which effectively increase market-clearing prices above competitive levels.

Figure 1

Welfare Effects of Regulation in a Revenue Supported Industry



In the case of agricultural price supports, the difference between average revenue and demand represents an explicit subsidy paid out of tax revenues. Agricultural marketing orders essentially set up discriminating monopoly schemes for allocating an industry's output among markets so that the pooled price (average revenue) producers receive exceeds demand. Import quotas effectively increase domestic excess demand above competitive levels, i.e., above the levels specified by the difference between domestic demand and foreign supply.

Figure 1 shows market equilibrium in a revenue-supported industry. Pre-regulation inverse supply is given by $S_1(Q)$ while producer price, P_1, and output, Q_1, are determined by the equality of average revenue and supply. The competitive equilibrium price and output before regulation are given by P_1^* and Q_1^*.

Assume that taxes are paid by consumers so that aggregate consumer welfare includes government expenditures as a negative element. Assume also that aggregate utility from consumption is measured by the area under the demand curve.[2] Net consumers welfare prior to regulation NCS_1 is simply the area under the demand curve less consumer expenditures (which equal producer revenues) and is, thus, given by the area (a+c) - (h+i+j+n+o). This net consumer welfare measure has three components. First, the area a+c represents the excess of consumer willingness to pay over actual price. Second, the negative area h+i+j represents a transfer of income from consumers to producers caused by the fact that consumers buy more than they desire at price P_1. Finally, the negative area n+o represents the deadweight loss to society from excess production and consumption.

Producer welfare prior to regulation PS_1 is given by the excess of producers' revenues over costs, that is, by the area g+h+i+j+k+l+m+p+q+r. This, too, has three components: producers' quasi rents in competitive equilibrium (p+q+r) and the two transfers of consumer income caused by the increase in price (g+h+l+m) and in quantity purchased (h+i+j) above the competitive equilibrium levels.

Finally, total welfare in the market W_1 is given by the sum of producers' and consumers' surpluses and is equal to the area (a+c+g+k+l+m+p+q+r) - (n+o), that is, total welfare under competitive equilibrium (a+c+g+k+l+m+p+q+r) less the deadweight loss n+o.

A. Market Impacts of New Regulation

Regulatory agencies typically have little or no influence over policies outside of their own specific jurisdictions regardless of whether such policies impinge on matters which concern them. The U. S. Environmental Protection Agency (EPA), for example, has jurisdiction over pesticide use--it rules on the legality or illegality of the use of particular pesticides for particular uses. It has no jurisdiction on preexisting policies like agricultural policy which exert influence on pesticide-use patterns; rather, it must take the existin policy environment as given. Thus, each agency is forced to behave as a policy taker, ruling within its own sphere of influence as if the policies of other agencies were fixed and immutable. In evaluating the economic costs of regulation, then, the agency must consider any prior policies as given.

Suppose that the government imposes a new, productivity-decreasing regulation on a revenue-supported industry. As Figure 1 illustrates, the new regulation causes a leftward shift in the supply curve from $S_1(Q)$ to $S_2(Q)$ reducing output from Q_1 to Q_2, raising the price from P_1 to P_2, and changing the competitive equilibrium price and quantity from (P_1^*, Q_1^*) to (P_2^*, Q_2^*).

Consider first the impact of the regulation on net consumer welfare. Net consumers' surplus after the regulation, NCS_2, is given by the area a - (d+e+h+i+n); thus, the effect of the regulation on gross consumer welfare, $\Delta NCS = NCS_2 - NCS_1$, is given by the area (j+o) - (c+d+e). Again, this effect has three components: The negative area c represents the reduction in consumer income due to higher prices on desired purchases, the negative area d+e represents the reduction in consumer income due to higher prices on excess purchases, and the positive area j+o represents the social gain arising from the reduction in excess output from Q_1 to Q_2.

Producer income after the regulation, PS_2, is given by the area e+d+g+h+k+p so that the effect of the regulation on producer welfare, $\Delta PS = PS_2 - PS_1$, is given by the area (c+d) - (i+j+l+m+q+r). This effect has three components as well. First, the regulation causes an increase in the cost of producing the equilibrium output Q_2 equal to the area e+i+l+m+q+r. Simultaneously, the reduction in output causes an increase in price and hence a revenue gain equal to the area c+d+e; as a result, the net increase in production cost is i+l+m+q+r since e is compensated for by the price increase. Finally, the reduction in output causes a reduction in quasi rents equal to the area j.

Total market welfare after the regulation W_2 is (a+c+g+k+p) - (e+i+n) so that the effect of the regulation on total market welfare, i.e., the market welfare impact of regulation, $\Delta W = W_2 - W_1$, is given by the area o -

(e+i+l+m+q+r) which equals the loss in production efficiency reflected in the increased cost of producing Q_2, given by the negative area e+i+l+m+q+r, plus the reduction in the excess of cost [S_1(Q)] over social value [D(Q)] caused by the decrease in excess production from Q_1 to Q_2. Alternatively, one can interpret ΔW in terms of the impact of regulation on global social efficiency. It is clear from Figure 1 that the area m+l+q+r represents the increased cost of producing the competitive equilibrium quantities before and after the regulation, i.e., m+l+q+r represents the market welfare impact of the regulation in competitive equilibrium. When government revenue supports are in effect, the regulation has an additional impact: By reducing excess output, it causes a change in deadweight loss from n+o to e+i+n--a net change of o - (e+i). Thus, the area o - (e+i+l+m+q+r) represents the total impact of the regulation on the social efficiency of production.

This analysis suggests regulation will tend to have different effects on welfare in a revenue-supported industry than in an industry in competitive equilibrium. In particular, when producer revenue supports are effective, (1) producers are more likely to lose from regulation; (2) consumers, as a group, may gain from regulation; and (3) new regulation may actually increase net social welfare.

Consider first the effect of regulation on producers. Whenever regulation increases the prices paid to producers (i.e., whenever demand is less than perfectly elastic), producers will be at least partially compensated for increases in production cost and decreases in sales. In industries where demand is inelastic, as is typical of those with revenue-support programs, these revenue increases will tend to exceed the sum of cost increases and sales reductions so that producers will tend to actually gain from regulation. By increasing the elasticity of average revenue, however, revenue-support programs reduce the size of regulation-induced revenue gains (d+d+e) relative to cost increases (e+i+l+m+q+r) and sales reductions (j), making it more likely that producers will lose from regulation. The existence of revenue-support programs may thus be expected to exert a strong influence on the attitudes of producers toward regulation: While producers in these industries might well support regulation under a competitive equilibrium regime, under revenue supports, they will tend toward firm opposition.

Revenue-support programs have the opposite effect on consumers. Under competitive equilibrium conditions, consumers always lose from regulation, especially when demand is inelastic. Revenue-support programs work to reduce these losses in two ways. First, by increasing the elasticity of average revenue, they moderate price increases and, hence, increases in consumer expenditures (c+d+e). Moreover, as long as revenue supports remain effective, all reductions in consumption will come out of excess purchases and hence represent a gain to consumers (j+o). It is thus possible that, instead of losing from regulation (and in the case of inelastic demand bearing the full cost of regulation), consumers may actually gain from regulation. As a result, one would expect revenue supports to strengthen consumer support for regulations to a significant extent.

With respect to total market welfare, it is evident that the market welfare effect of regulation will be nonnegative whenever o is larger than e+i+l+m+q+r, so that regulation will not cause a loss in social welfare but will either be neutral or will increase social welfare. Instead of introducing a deadweight loss, regulation decreases the size of the deadweight loss already present, at times sufficiently to outweigh producer losses. It is thus incorrect to assume a priori that regulation will cause social losses (have a negative market welfare effect) that must be weighed against a separate set of gains (e.g., of environmental quality or human health and safety). Instead, regulation may be justifiable simply because it reduces inefficiencies caused by prior policies. Regulating agricultural pesticides, for example, may be justified on efficiency grounds even apart from its effects on environmental externalities.

B. The Characteristics of the Market Welfare Impact

The size and sign of the market welfare impact of regulation in a revenue-supported industry depend on several key factors, notably the level of government support, the stringency of the regulation, and the characteristics of the market, i.e., the elasticities of average revenue and supply.

Consider first the impact of a general increase in government revenue support represented by a parallel upward shift in the AR curve in Figure 1. Obviously, such a shift will produce higher prices and quantities before and after regulation, thereby increasing both the positive area o and the negative area e+i+n. Because the vertical distance between average revenue and demand is greater at Q_1 than at Q_2, the increase in o will exceed the increase in e+i+n as long as Q_2 does not increase much more than Q_1, which, as we show in Appendix A, will be the case as long as excess supply, $[S_i(Q_i) - AR(Q_i)]$, is not considerably more elastic at Q_2 than Q_1. Since one could not expect the elasticity of excess supply to differ greatly before and after regulation, one can conclude that, in general, an increase in government revenue support will decrease net market losses from regulation.

To examine the impact of an increase in regulatory stringency, i.e., the restrictions on production imposed by regulation, suppose that the post-regulation inverse supply curve, S_2, shifts upward causing output to decline further (Q_2 decreases) and price to rise higher (P_1 increases). This shift in S_2 has two effects on the net market impact. On the one hand, the cost of producing postregulation output will increase as shown by an increase in the negative area e+i+l+m+q+r. On the other hand, the fall in output results in a decrease in postregulation deadweight less equal to the reduction in the e+i+n. As we show in Appendix A, unless the cost effect is quite small and/or excess supply is quite elastic, the cost effect will outweigh the output effect so that, in general, an increase in regulatory stringency will increase net market losses from regulation.

The impact of an increase in the elasticity of average revenue can be examined by considering a shift which flattens the average revenue curve around the initial market price and quantity, i.e., a rotation of AR around (P_1, Q_1). It is easy to see from Figure 1 that this rotation of the AR curve reduces both P_2 and Q_2, thereby reducing postregulation deadweight loss area e+i+n. As a result, one can conclude that an increase in the elasticity of average revenue will decrease net market losses from regulation.

The impact of an increase in the elasticity of supply can be examined by considering a similar rotation of the inverse supply curve around both the pre- and postregulation output levels, Q_1 and Q_2. As is shown in Appendix A, if the shift in supply caused by regulation is relatively unaffected by the increase in the elasticity of supply, as would appear to be reasonable, an increase in the elasticity of supply will decrease net market losses from regulation. The intuition here is straightforward. As long as the regulatory shift is relatively independent of the elasticity of supply, the increase in the cost of producing Q_2 caused by the regulation remains unaffected by changes in the elasticity of supply. However, the total cost of producing $Q_1 - Q_2$ prior to the new regulation will have increased which means that producers' preregulation profits will have been lower and hence new regulation will cause smaller losses.

C. The Specification Bias of the Standard Procedure

Welfare analyses are typically performed under the assumption that markets are in competitive equilibrium before and after regulatory measures are taken. When there are revenue-support programs effective in the industry in question, following this procedure means using a misspecified model; thus, standard methods can be expected to introduce specification biases into welfare estimates. The exact nature of the misspecification depends critically on the specific policy involved so that these biases can only be explored in the context of specific models. Thus, further discussion of this issue is relegated to the case of price supports examined below.

II. The Case of Agricultural Price Supports

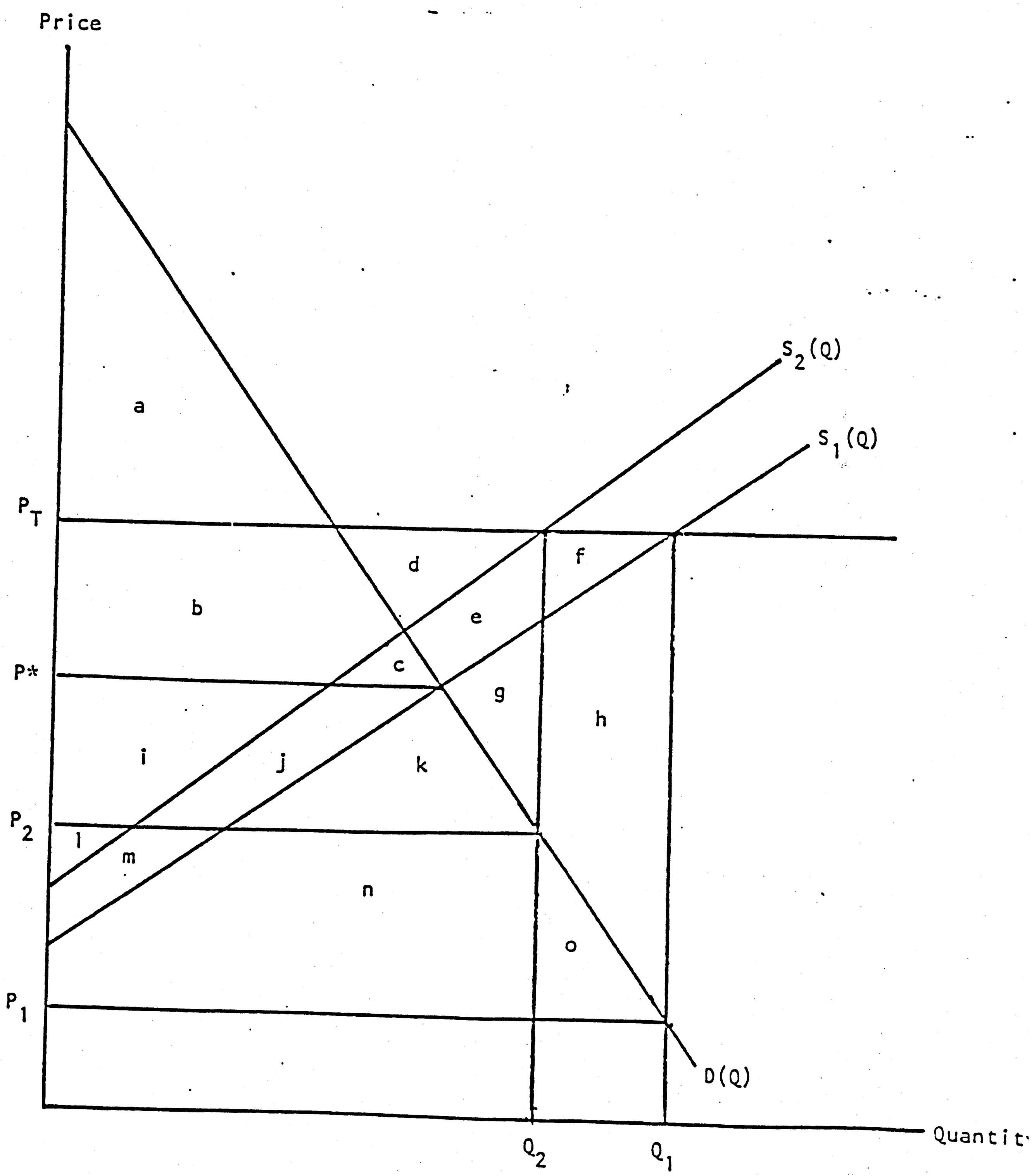
Perhaps the most important examples of revenue-support programs are the price-support policies used in agriculture. The most important of these is the target-price scheme, which operates essentially as follows. Output is sold at the market price; when the market price falls below the target price, producers receive from the government a subsidy (known as the deficiency payment) equal to the difference between the two. When the competitive market-clearing price is below the target price, the target price becomes the effective price received by producers and thus the relevant price for production decisions, while output will be absorbed by consumers at a market price determined by the demand curve.[3]

This mechanism is illustrated in Figure 2. The target price is denoted by P_T, inverse supply by $S_1(Q)$, and inverse demand by $D(Q)$. Prior to the imposition of regulation, farmers produce output, Q_1, determined by the rule, $P_T = S_1(Q_1)$. The market price, P_1, is determined by $P_1 = D(Q_1)$; and the government subsidy (or deficiency payment) is $P_T - P_1$ for each unit produced. Average revenue equals demand for prices greater than the target price and the target price thereafter. In this case, net consumer welfare can be decomposed into consumers' surplus and government expenditures; thus, it is possible to differentiate between the impact of regulation on consumer welfare narrowly construed and the impact on the U. S. Treasury costs of the price-support program.

Following T. D. Wallace (1962), Bruce Gardner (1983), and Richard E. Just (1985), the components of market welfare in this case are as shown in Figure 2. Let P* denote competitive equilibrium price which would hold without the target price program before any input regulation. Consumers' surplus consists of the consumers' surplus under perfect competition (i.e., without intervention)--a+b+c plus government subsidized consumption i+j+k+l+m+n+o. Producers' surplus similarly consists of the perfect competition amount (i+j+l+m) plus government transfer payments (b+c+d+e+f). Government expenditures, $(P_T - P_1)\,Q_1$, consists of these transfer payments to consumers (i+j+k+l+m+n+o) and producers (b+c+d+e+f) plus a deadweight loss

Figure 2

Welfare Effects of Regulation in an Industry
With Price Supports



equal to g+h. Finally, total market welfare equals the standard competitive equilibrium surplus (a+b+c+i+j+k+l+m) minus the deadweight loss (g+h).

A. The Market Impact of Regulation

Suppose that the government imposes a new regulation on a market with price supports. As Figure 2 illustrates, the new regulation causes a leftward shift in the supply curve from $S_1(Q)$ to $S_2(Q)$ reducing output from Q_1 to Q_2 and raising the equilibrium price from P_1 to P_2. By reducing output and increasing price, regulation causes a loss in consumers' surplus equal to the area l+m+n+o and a loss in producers' surplus equal to the area c+e+f+j+m, while U. S. Treasury costs decrease by an amount equal to the area f+h+l+m+n+o. One part of the savings in government expenditure, l+m+n+o, exactly matches the loss in consumers' surplus. Because this part of consumption is entirely subsidized, the aggregate consumer loss exactly matches the savings to the taypayers. Similarly, another part of government savings, f, matches part of the loss in producers' surplus; this, too, is a reduction in subsidization which has no net effect on social welfare. Thus, the net change in social welfare is h - (c+e+j+m).

As before, one can also interpret this market welfare effect in terms of the impact of regulation on social efficiency. It is clear from Figure 2 that the area c+j+m represents the social loss due to the increased cost of producing the competitive equilibrium quantities before and after regulation. In other words, c+j+m represents the net economic cost of regulation in competitive equilibrium. When government subsidies are present, regulation causes an additional effect, namely, a reduction in deadweight loss from g+h to e+g, a net change of h-e. Thus, h-e-c-j-m represents the changes on the social efficiency of production caused by regulation.

Unlike the general case under price supports, the net effect of regulation on consumers in their dual role of consumers/taxpayers is always positive while the effect on producers is always negative. It is thus evident that the distribution of gains and losses from regulation under price supports will be the exact opposite of the situation under competitive equilibrium; hence, price supports will strengthen producers' opposition to regulation and consumers' support for regulation.

The size and sign of the market welfare effect of regulation in a price-supported industry depend on the target price, the stringency of the regulation, and the elasticities of supply and demand. It is not hard to modify the results given in Appendix A to show that (1) an increase in the target price will decrease net market losses from regulation, (2) an increase in regulatory stringency will increase net market losses from regulation, (3) an increase in the elasticity of demand will decrease net market losses from regulation, and (4) an increase in elasticity of supply will decrease net market losses from regulation.

B. The Specification Bias of the Standard Procedure

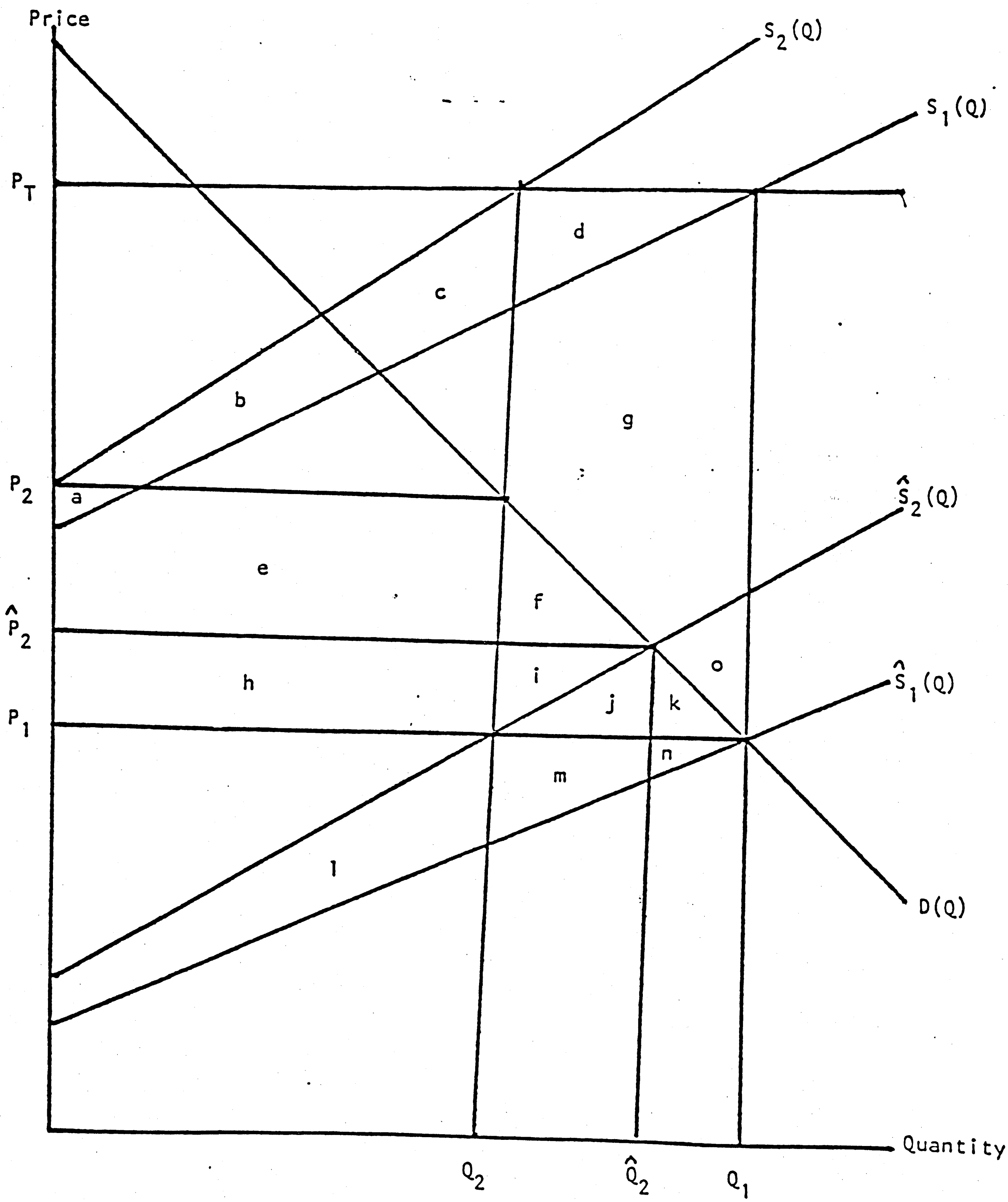
Welfare analyses are typically performed under the assumption that markets are in competitive equilibrium before and after regulatory measures are taken. When the industry in question has effective price supports, following this procedure means using a misspecified model, and the standard methods can be expected to introduce specification biases into welfare estimates. This section examines the characteristics of these biases. Since demand is not affected by target prices, it will be assumed that the true inverse demand curve, D(Q), is used. The estimated inverse supply curve, $\hat{S}_1(Q)$, will be formed by shifting the true curve, $S_1(Q)$, downward sufficiently to intersect the inverse demand curve at (P_1, Q_1). An illustration of the relationship between the estimated and true models is given in Figure 3.

Consider first the estimate of the loss in consumers' surplus generated by the standard model. Let $\hat{S}_2(Q)$, $\hat{Q}_2$, and $\hat{P}_2$ denote estimated post-regulation inverse supply, predicted output, and predicted price, respectively. As one can see from Figure 3, the true loss in consumers' surplus is a+e+f+h+i+j+k while the estimated loss is only h+i+j+k, leaving a+e+f as the specification bias of the standard procedure. (An algebraic derivation is given in Appendix B.) Thus, the standard method underestimates consumer losses from regulation. Intuitively, because equilibrium output is determined by movements along the demand curve in the misspecified model, the impact of new regulation on output and price is always underestimated: The predicted quantity is larger and the predicted price lower than will actually be the case. As a result, consumers' losses are underestimated as well.

As one can see from Figure 3, the estimated loss in producers' surplus equals the increased cost of producing $\hat{Q}_2$ less the revenue gain due to the estimated increase in price from P_1 to $\hat{P}_2$ and is thus equal to the area l+m+n - (h+l). The true loss in producers' surplus, of course, equals the area a+b+c+d. In Figure 3 the estimated pre- and postregulation supply curves, S_1 and S_2, are assumed to be parallel to their true counterparts. When this assumption holds, l+m+n = a+b+c+d; and the true loss in producers' surplus exceeds the estimated loss by an amount equal to h+i. In Appendix B it is shown that the estimated loss to producers will exceed the true loss only when the estimated preregulation supply curve is considerably steeper

Figure 3

Specification Bias of the Competitive Equilibrium Assumption



than its true counterpart. In general, then, one can conclude that the standard method underestimates producer losses from regulation.

In competitive equilibrium, regulation always causes a net loss in social welfare, i.e., the net market effect of regulation is always negative. In Figure 3 the estimated market welfare effect is thus the negative area j+k+l+m+n. However, the true market welfare effect is the area g+o - (a+b+c). Since a+b+c+d = l+m+n in this case, the estimated market welfare effect exceeds the true market welfare effect by an amount equal to the area d+g+o+j+k. In Appendix B, it is demonstrated that the estimated market welfare loss always exceeds the true value, i.e., that the standard method overestimates net market losses from regulation. This bias arises because the standard method ignores the positive impact of reductions in government revenue support program payments on market welfare. As it turns out, these reductions are always large enough to outweigh the biases in the estimation of consumers' and producers' losses.

In sum, the standard procedure of assuming competitive equilibrium will always produce biased estimates of the welfare effects of secondary regulation in a revenue-supported industry. In particular, the standard procedure overestimates the market welfare impact of regulation and can thus be said to be biased against regulation. In follows that the market welfare effect of regulation will be smaller than that estimated, so that regulation is more desirable than standard analyses indicate.

C. Empirical Examples

The price-support form of government subsidization is found most commonly in agriculture; thus, one would expect agriculture to provide good examples of the impact of price-support programs on the net market effect of regulation, on the distribution of costs between producers and consumers, and on the specification bias caused by an erroneous assumption of a competitive equilibrium framework.

This section uses the case of a regulations-restricting production of the five most important U. S. crops (corn, cotton, rice, sorghum, and wheat) covered by effective price supports to illustrate these effects. It was assumed that the elasticities of supply and demand were constant for all five crops so that the inverse demand for each crop, D(Q), had the form $a_0Q^{b_1}$ and the inverse supply before regulation, $S_1(Q)$, had the form $b_0Q^{b_1}$ and that the ban on the pesticide decreased supply by t percent so that the inverse supply after regulation, $S_2(Q)$, had the form $(1+t)b_0Q^{b_1}$. Estimates of the elasticities of supply and demand were taken from a number of sources; both the estimates and their sources are shown in Table 1. Estimates of output target prices and market prices, also shown in Table 1, were chosen to be broadly representative of the levels prevailing in recent years (see U. S. Department of Agriculture, 1983). The parameters a_0 and b_0 were chosen to equate inverse demand with the market price and inverse supply with the target price at current output levels. The inverse supply curve, $\hat{S}_1(Q)$, estimated under the assumption of competitive equilibrium prior to the pesticide ban, was formed by choosing the parameter $\hat{b}_0$ to equate inverse supply with the market price at current output levels. The regulations were assumed to decrease the supply of these crops by 1 percent (a figure which appears to be not atypical of pesticide bans; see, for instance, National Academy of Sciences, 1983). The model was then used to calculate the welfare effects of the ban with and without price supports and the welfare effects estimated

TABLE 1

Model Parameters

Crop	Elasticity of supply	Elasticity of demand	Output (billion bushels)	Market price (dollars/bushel)	Target price (dollars/bushel)
Corn	.30	-.50	8.00	2.50	3.00
Cotton[a]	.50	-.41	12.00	.80	.60
Rice[b]	.80	-.43	.15	9.00	11.90
Sorghum	.71	-.83	.85	2.40	2.90
Wheat	.30	-.99	2.50	4.40	3.40

[a]Output measured in bales and price in dollars per pound.

[b]Quantities measured in hundredweight.

Sources: Rice supply, Collins and Evans; sorghum supply, Gallagher and Green; corn and wheat supply and demand, Gardner (1984); rice demand, Grant, Beach, and Lin; sorghum demand, Grant and Hoskin; cotton demand, Townsend; cotton supply, Townsend, Skelly, and Sronce; quantities, market prices, and target prices, U. S. Department of Agriculture.

under an incorrect assumption of competitive equilibrium when price supports were present.

The results of this procedure, shown in Table 2, demonstrate that (1) savings in U. S. Treasury costs from regulation are quite substantial, (2) price supports cause sizable changes in the welfare effects of regulation, (3) regulation will have no net market effect for target prices not too much greater than those currently in force, and (4) treating the behavior observed under price supports as if it were generated by competitive equilibrium leads to substantial overestimation of the net market effect of regulation.

First, note that the savings in U. S. Treasury costs associated with regulation are quite high for all of these crops. At current target price levels, for example, the ratio of government savings to the sum of producers' and consumers' losses ranges from a low of .65 for wheat, to about .75 for corn and sorghum, and to roughly .85 for cotton and rice. Consequently, it is apparent that ignoring this component of market welfare will lead to serious distortions in evaluating policy alternatives.

Second, compare the welfare effects of regulation in competitive equilibrium with those with target prices at current levels. In competitive equilibrium, producers gain from the ban in every case and substantially so in the cases of corn ($30 million), cotton ($17 million), and rice ($3 million). As a result, one would expect members of this group (or at least some sections of it) to support regulation. Consumers, on the other hand, sustain substantial losses from the ban in every case--$10 million for rice and sorghum, $20 million for wheat, $43 million for cotton, and $77 million for corn. (In the case of pesticides, for example, one would thus expect only the more environmentally minded members of this group to support regulation.)

TABLE 2

Welfare Effects of a Pesticide Ban

	ΔCS	$\Delta \widehat{CS}$	ΔPS	$\Delta \widehat{PS}$	ΔGP	$\Delta CS-\Delta GP$	ΔW	$\Delta \widehat{W}$
				(million dollars)				
CORN								
Competitive equilibrium	- 77.30		29.73				-47.57	
Target price (dollars per bushel)								
3.00[a]	-119.58	-74.70	- 55.03	28.73	-131.33	11.74	-43.28	-45.97
3.50	-114.18	-71.32	- 67.24	29.13	-144.50	30.32	36.92	-46.19
4.00	-109.69	-68.52	- 79.98	21.73	-158.82	49.13	-30.85	-47.79
4.50	-105.89	-66.14	- 93.22	18.47	-174.13	68.24	-24.98	-47.67
5.00	-102.59	-64.09	-106.90	15.30	-190.26	87.67	-19.23	-48.78
5.50	- 99.70	-62.28	-121.00	12.19	-207.15	107.45	-13.55	-50.09
6.00	- 97.13	-60.67	-135.49	9.11	-224.71	127.58	- 7.92	-51.56
6.50	- 94.83	-59.23	-150.35	6.07	-242.87	148.04	- 2.31	-53.17
COTTON								
Competitive equilibrium	- 43.28		17.02				-26.26	
Target price (dollars per pound)								
0.80[a]	- 87.68	-39.43	- 31.76	15.51	- 99.38	11.69	-20.07	-23.92
0.90	- 80.56	-36.22	- 37.90	12.12	-104.38	23.82	-14.08	-24.10
1.00	- 74.68	-33.58	- 44.39	8.97	-110.64	35.97	- 8.42	-24.60
1.10	- 69.73	-31.35	- 51.21	6.00	-117.96	48.23	- 2.98	-25.36
1.20	- 65.50	-29.45	- 58.35	3.13	-126.17	60.67	2.32	-26.32
1.30	- 61.83	-27.80	- 65.79	0.34	-135.17	73.34	7.55	-27.46
1.40	- 58.62	-26.36	- 73.53	- 2.40	-144.88	86.26	12.73	-28.76
1.50	- 55.78	-25.08	- 81.55	- 5.11	-155.24	99.45	17.91	-30.19
RICE								
Competitive equilibrium	- 9.71		3.07				- 6.63	
Target price (dollars per hundredweight)								
11.90[a]	- 25.12	- 8.75	- 7.86	2.77	- 28.47	3.35	- 4.51	- 5.98
12.30	- 24.26	- 8.45	- 8.34	2.46	- 28.85	4.59	- 3.76	- 5.99
12.70	- 23.45	- 8.17	- 8.84	2.16	- 29.28	5.83	- 3.01	- 6.01
23.10	- 22.69	- 7.91	- 9.34	1.87	- 29.76	7.07	- 2.28	- 6.04
13.50	- 21.98	- 7.66	- 9.87	1.58	- 30.29	8.31	- 1.56	- 6.08
13.90	- 21.31	- 7.42	-10.40	1.30	- 30.85	9.56	- 0.84	- 6.12
14.30	- 20.68	- 7.20	-10.94	1.02	- 31.49	10.81	- 0.14	- 6.18
14.70	- 20.08	- 7.00	-11.50	0.74	- 32.15	12.07	0.57	- 6.25
SORGHUM								
Competitive equilibrium	- 9.50		0.94				- 8.56	
Target price (dollars per bushel)								
2.90[a]	- 17.38	- 9.36	- 10.15	0.93	- 20.31	2.93	- 7.22	- 8.43
3.10	- 17.21	- 9.27	- 11.37	0.84	- 22.38	5.17	- 6.21	- 8.44
3.30	- 17.05	- 9.19	- 12.66	0.74	- 24.54	7.49	- 5.17	- 8.45
3.50	- 16.91	- 9.11	- 14.00	0.64	- 26.81	9.90	- 4.10	- 8.47
3.70	- 16.77	- 9.04	- 15.39	0.53	- 29.17	12.40	- 2.99	- 8.50
3.90	- 16.64	- 8.97	- 16.84	0.43	- 31.63	14.99	- 1.86	- 8.50
4.10	- 16.52	- 8.90	- 18.35	0.32	- 34.18	17.66	- 0.69	- 8.58
4.30	- 16.41	- 8.84	- 19.90	0.21	- 36.82	20.41	0.51	- 8.65

(Continued on next page.)

TABLE 2--continued.

	ΔCS	$\Delta\hat{CS}$	ΔPS	$\Delta\hat{PS}$	ΔGP	ΔCS-ΔGP	ΔW	$\Delta\hat{W}$
	(million dollars)							
WHEAT								
Competitive equilibrium	- 19.69		0.15				-19.54	
Target price (dollars per bushel)								
4.40[a]	- 25.62	-19.69	- 25.22	0.15	- 33.04	7.42	-17.80	-19.54
4.90	- 25.62	-19.69	- 29.01	0.14	- 37.97	12.35	-16.66	-19.54
5.40	- 25.62	-19.69	- 32.91	0.14	- 43.04	17.43	-15.49	-19.49
5.90	- 25.62	-19.64	- 36.93	0.13	- 48.27	22.65	-14.28	-19.52
6.40	- 25.62	-19.64	- 41.05	0.12	- 53.62	28.00	-13.05	-19.52
6.90	- 25.57	-19.64	- 45.27	0.12	- 59.10	33.53	-11.74	-19.52
7.40	- 25.57	-19.64	- 49.58	0.11	- 64.71	39.14	-10.44	-19.53
7.90	- 25.57	-19.64	- 53.97	0.10	- 70.42	44.86	- 9.12	-19.54

[a]Denotes current target price.

With price supports, the situation is reversed: Consumers in their dual role as consumers/taxpayers benefit unambiguously--and considerably--to the tune of $3 million for rice and sorghum, $7 million for wheat, and $12 million for corn and cotton and can thus be expected to support regulation more wholeheartedly, while producers suffer rather large losses--about $8 million for rice, $10 million for sorghum, $25 million for wheat, $32 million for cotton, and $55 million for corn. One can thus target agricultural policy as a key determinant of the political-economic conditions affecting environmental regulation in agriculture, in particular, the entrenchment of farmers' opposition to this type of intervention.

The third point of interest is that, for several crops (cotton, rice, and sorghum), regulation will have no net market effect at target prices not much greater than those currently in effect. For cotton, the zero-impact target price is only 37 cents per pound (about 45 percent) higher than the current target price; for sorghum, it is only $1.32 per bushel (about 45 percent) higher; and for rice, only $2.48 per hundredweight (about 20 percent) higher. One can see that the net market effect of regulation is both lower and declines more rapidly as supply becomes more elastic. For example, corn, cotton, and rice have roughly the same elasticities of demand (.4 to .5), while rice has a supply elasticity nearly twice that of cotton which has a higher supply elasticity of nearly twice that of corn. Correspondingly, the proportional increase in the target price of rice required to produce a zero net market impact from the ban is only about one-half that required for cotton and only about one-sixth that required for corn. Finally, sorghum and wheat have roughly the same demand elasticities, while sorghum has an elasticity of supply over twice that of wheat and requires only one-third of the proportional increase in target price to reach a zero net market impact. The impact of demand elasticity is less straightforward since a high elasticity of demand reduces both the net market effect and the rate of decline with respect to the target price. For example, wheat has the same elasticity of supply as corn but an elasticity of demand about twice as large. The net market impact of regulation on wheat is, correspondingly, only one-half of that for corn at current target prices; the proportionate increase in target price required to attain a zero net market impact for wheat is, nevertheless, higher than that for corn.

The implication of these results is that environmental regulation becomes more attractive as government subsidization of agriculture grows, especially in markets where supply is less inelastic. This is particularly important for crops such as cotton and rice which are among the largest users of inputs implicated in many environmental and resource problems (e.g., water and pesticides); for these crops, relatively small increases in subsidies serve to eradicate market losses from environmental regulation.

Finally, it is evident that treating markets with price supports as if they are in competitive equilibrium leads to significant overestimation of the net economic costs of the pesticide ban. It is instructive to note that the welfare effects estimated using the true inverse supply curve under a competitive equilibrum assumption (the "textbook model") and those estimated using the inverse supply curve estimated under the assumption of competitive equilibrium as described in Section II (the "estimated model") are essentially identical, so that either model can be said to give an accurate description of the welfare effects of regulation in competitive equilibrium. In every case net market losses from regulation in competitive equilibrium are substantially higher than net market losses at current target price levels--about 10 percent higher for corn and wheat, 20 percent higher for sorghum, over 30 percent higher for cotton and almost 50 percent higher for rice in the textbook model and 6 percent higher for corn, 10 percent higher for wheat, close to 20 percent higher for sorghum and cotton, and about 33 percent higher for rice in the estimated model. The size of the bias clearly increases as the elasticity of supply increases since it is small for the most inelastic crops (corn and wheat), larger for the less inelastic (sorghum and cotton), and largest for the least inelastic (rice). A larger elasticity of demand appears to have contradictory effects on the size of the bias since sorghum has more elastic supply and demand for cotton yet a higher elasticity of demand than corn and a slightly higher bias.

These results imply that the use of a competitive equilibrium framework may introduce serious errors into regulatory welfare analyses, errors which may well be sufficiently serious to bring about significant alterations in regulatory policy. Producers whose supply is less inelastic are of particular concern in this regard. Thus, these errors were relatively small for corn and wheat, crops whose supplies are rather inelastic, and quite large--on the order of one-third to one-half of the true net market impacts--for more elastic crops such as cotton and rice.

This analysis has some interesting implications for pesticide regulation in particular. Crops such as cotton and rice number among the largest users of pesticides and, hence, among the crops most affected by pesticide regulation. The analysis suggests that the regulatory welfare analyses performed up until the present have overstated the net market impact of pesticide regulation by a significant margin (e.g., 30 percent for cotton and

50 percent for rice) and hence that the EPA should be regulating many pesticides much more stringently than has been its practice.

III. Conclusion

Government regulation has become sufficiently pervasive that new regulations are impinging on preexisting policies to an increasing extent. Evaluations of the market effects of newer regulations must, therefore, take account of these prior regulations. This paper has developed a framework for analyzing the market welfare effects of regulation for the case of a pre-existing regime of revenue-support programs. To facilitate the analysis, several simplifications were made. First, many revenue-support programs have specific secondary features which were ignored, for example, the set-aside requirements of agricultural price-support programs. Second, regulation may influence prior policies so that their true impact on the market is dynamic. For example, environmental regulation in agriculture may increase production costs and thereby induce increases in target prices since the latter are pegged to costs. The framework developed here treated policies in a static Cournot-Nash way; a more complete analysis would address these feedback effects. Nevertheless, the presence of these prior policies was shown to cause striking alterations in the welfare effects of new regulations; in addition, these changes were significant enough both qualitatively and quantitatively to indicate that ignoring prior policies introduces serious distortions into regulatory welfare analyses.

The theoretical portion of the paper showed first that the distribution of the welfare effects of regulation under revenue supports tends to be opposite of that under competitive equilibrium: Under revenue supports, producers tend to lose and consumers tend to gain whereas, under competitive equilibrium, consumers always lose and producers may gain, especially in industries facing inelastic demand as revenue-supported industries tend to be. Second, under revenue supports, regulation may have no net effect on market welfare and may even result in gains in social welfare. Market welfare losses from regulation is shown to be smaller with higher revenue support, more elastic supply and average revenue, and less stringent regulation. Third, treating markets with revenue supports as if they were in competitive equilibrium produces biased estimates of the welfare effects of new regulation: In the price support case, the costs to consumers and producers are underestimated; but the market welfare effect is overestimated, making regulation seem less desirable than it actually is.

The framework was then applied to the case of regulations affecting the five most important agricultural commodities with effective support programs: corn, cotton, rice, sorghum, and wheat. The savings in U. S. Treasury costs turned out to be rather large relative to consumers' and producers' losses. Price supports were shown to have large effects on the distribution of costs in the majority of cases turning significant gains for producers into sizable losses and sizable losses to consumers into noticeable gains. For the majority of crops, the target price at which regulation had zero market welfare impact turned out to be not too much higher than the levels currently in effect. Finally, the use of a competitive equilibrium framework was shown to introduce significant biases into estimates of the market welfare effects of regulation: for some crops, the upward bias was on the order of one-third to one-half of the actual market welfare effect.

It should be noted that this analysis was conducted from the point of view of economic efficiency and that these results were derived on the basis of efficiency considerations alone. While important, efficiency is not the only factor affecting regulatory decisions; for example, the redistribution of income inherent in revenue-support programs may have some explicit social utility or may arise from rent-seeking behavior or other political factors. The impact of regulation in revenue-supported industries on equity and political economic considerations is thus also an area of considerable interest and deserves further investigation.

APPENDIX A

This Appendix provides algebraic derivations of the impacts of various factors on the net economic cost of regulation. In the general case, the equilibrium market prices before and after regulation are determined by the relation:

$$AR(Q_i) = S_i(Q_i), \qquad i = 1, 2. \tag{A1}$$

Consumers' surplus before and after regulation is:

$$CS_i = \int_0^{Q_i} D(Q)\, dQ - P_i\, Q_i, \qquad i = 1, 2 \tag{A2}$$

so that the effect of regulation on consumers is:

$$\Delta CS = CS_2 - CS_1 = P_1\, Q_1 - P_2\, Q_2 - \int_{Q_2}^{Q_1} D(Q)\, dQ. \tag{A3}$$

Producers' surplus before and after regulation is:

$$PS_i = P_i\, Q_i - \int_0^{Q_i} S_i(Q)\, dQ, \qquad i = 1, 2, \tag{A4}$$

so that the effect of regulation on producers is:

$$\Delta PS = P_2\, Q_2 - P_1\, Q_1 - \int_0^{Q_2} [S_2(Q) - S_1(Q)]\, dQ + \int_{Q_2}^{Q_1} S_1(Q)\, dQ. \tag{A5}$$

Finally, the effect of regulation on total welfare, that is, the net economic cost of regulation, is the sum of (A3) and (A5):

(A6)
$$\Delta W = \int_{Q_2}^{Q_1} [S_1(Q) - D(Q)]\, dQ - \int_{0}^{Q_2} [S_2(Q) - S_1(Q)]\, dQ.$$

To explore the impact of a general increase in government revenue support on the net market effect, rewrite the average revenue curve as an increasing function of Q and a policy shifter z, AR(Q, z), where larger values of z represent increases in government support. From (A6), it is evident that:

(A7)
$$\frac{\partial \Delta W}{\partial z} = [P_1 - D(Q_1)] \frac{\partial Q_1}{\partial z} - [P_2 - D(Q_2)] \frac{\partial Q_2}{\partial z}.$$

For the case of a parallel shift in the average revenue curve, $\partial AR/\partial Q = k$ for all Q; this can be rewritten using (A1) as:

(A8)
$$\frac{\partial \Delta W}{\partial z} = k[(1 - r_1)\, Q_1\, e(Q_1) - (1 - r_2)\, Q_2\, e(Q_2)]$$

where $r_i = D(Q_i)/P_i$, the ratio of demand price to market price; and $e(Q_i)$ represents the elasticity of excess supply at Q_i, $S_i(Q_i) - AR(Q_i)$. Obviously, $\partial \Delta W/\partial z < 0$ only when $e(Q_2)/e(Q_1) > (1 - r_1)\, Q_1/(1 - r_2)\, Q_2 > 1$.

To explore the impact of changes in regulatory stringency on the net market effect, let $S_2(Q) - S_1(Q) = T(Q, t)$ where t is a parameter which increases the size of the shift, i.e., $\partial T/(\partial t) > 0$. Increased stringency will be taken to mean a larger regulatory shift, i.e., an increase in t. Using (A6) and (A1), it is straightforward to show that:

(A9)
$$\frac{\partial \Delta W}{\partial t} = -[P_2 - D(Q_2)]\,\frac{\partial Q_2}{\partial t} - \int_0^{Q_2} \frac{\partial T(Q,\ t)}{\partial t}\,dQ$$

$$= (1 - r_2)\ Q_2\ e(Q_2)\,\frac{\partial T(Q_2)}{\partial t} - \int_0^{Q_2} \frac{\partial T(Q,\ t)}{\partial t}\,dQ.$$

Unless $e(Q_2)$ is relatively large or $\int_0^{Q_2} \partial T(Q,\ t)/(\partial t)\ dQ$ is quite small, $\partial \Delta W/(\partial t) < 0$.

To derive the impact of an increase in the elasticity of demand, let $\partial AR/(\partial z) \gtreqless 0$ as $Q \gtreqless Q_1$ so that (A7) becomes:

(A10)
$$\frac{\partial \Delta W}{\partial z} = -[P_2 - D(Q_2)]\,\frac{\partial Q_2}{\partial z} > 0.$$

Similarly, the effect of an increase in the elasticity of supply can be derived by rewriting S_i as a function of a shifter n such that $\partial S_i/(\partial n) \gtreqless 0$ as $Q \lesseqgtr Q_i$. It follows that

(A11)
$$\frac{\partial \Delta W}{\partial n} = \int_{Q_2}^{Q_1} \frac{\partial S_1(Q,\ n)}{\partial n}\,dQ - \int_0^{Q_2} \frac{\partial T(Q,\ t,\ n)}{\partial n}\,dQ$$

which is positive whenever $\partial T/(\partial n) = 0$, as one would expect to be the case.

APPENDIX B

This Appendix derives the specification biases introduced into welfare estimates by the application of a competitive equilibrium model to a market with a target price program. Output before and after regulation is determined by the relation:

(B1) $$P_T = S_i(Q_i)$$

while market price is determined by:

(B2) $$P_i = D(Q_i).$$

Since demand is not affected by target prices, it will be assumed that the true inverse demand curve D(Q) is used. The estimated inverse supply curve, $\hat{S}_1(Q)$, will be formed by shifting the true curve, $\hat{S}_1(Q)$, downward sufficiently to intersect the inverse demand curve at (P_1, Q_1). Represent this shift by an arbitrary function $R(Q) > 0$ so that:

(B3) $$\hat{S}_1(Q) = S_1(Q) - R(Q).$$

Consider first the estimate of the loss in consumers' surplus generated by the standard model. Letting $\hat{S}_2(Q)$, $\hat{Q}_2$, and $\hat{P}_2$ denote postregulation inverse supply, predicted output, and predicted price, respectively, it is straightforward to show that the estimated change in consumers' surplus, ΔCS, is related to the true change in consumers' surplus by

(B4) $$\Delta\hat{CS} = \Delta CS + (P_2 + \hat{P}_2)\ Q_2 + \int_{Q_2}^{Q_2} [D(Q) - P_2]\ dQ.$$

Since $D(Q) > P_2$ for $Q < Q_2$, it is evident that $\Delta CS > \Delta CS$, that is, that <u>the standard method underestimates consumer losses from new regulation</u>.

It is similarly straightforward to show that the estimated change in producers' surplus is related to the actual change by

$$\text{(B5)} \qquad \widehat{\Delta PS} = \Delta PS + \int_{Q_2}^{\hat{Q}_2} [P_2 - S_2(Q)]\, dQ + (\hat{P}_2 - P_1)\, Q_2$$

$$+ \int_{Q_2}^{Q_1} [P_T - P_1 - R(Q)]\, dQ.$$

It is obvious that $P_2 > S_2(Q)$ for $Q < Q_2$ and that $P_2 > P_1$ so that the second two terms on the right-hand side of (B5) are both positive. The final term represents an additional adjustment for the nature of the shift from the true supply curve to the estimated curve. If the shift is parallel, $R(Q) = P_T - P_1$ for all Q and the final term is zero. Insofar as the shift is more (less) than parallel, the final term is negative (positive). In general, one would expect this term to be small relative to the other two. Thus, one can conclude that the <u>standard method tends to underestimate producer losses from new regulation</u> even though it remains possible that the standard method will overestimate the cost of new regulation to producers.

Finally, using the standard relation, $\Delta W = \Delta PS + \Delta CS$, one obtains

$$\text{(B6)} \qquad \widehat{\Delta W} = \Delta W + \int_{Q_2}^{\hat{Q}_2} [D(Q) - S_2(Q)]\, dQ - \int_{\hat{Q}_2}^{Q_1} R(Q)\, dQ.$$

Since $D(Q) < S_2(Q)$ in the relevant range and $R(Q) > 0$ everywhere, the second and third terms on the right-hand side are both negative. Thus, $\Delta\hat{W} < \Delta W$, and the standard method overestimates the net economic cost of secondary regulation.

FOOTNOTES

[1] Although the information described in this article has beeen funded wholly or in part by the U. S. Environmental Protection Agency under assistance agreement CR811200-02 to the Western Consortium for the Health Professions, it has not been subjected to the Agency's required peer and administrative review and, therefore, does not necessarily reflect the views of the Agency; thus, no official endorsement should be inferred.

[2]No welfare connotations will be attached to the area between the average revenue and demand curves. This area may reflect the social benefits of redistributing income to producers or may equally be the result of producers' rent-seeking behavior. This analysis follows traditional welfare theory which emphasizes efficiency considerations and will, thus, exclude any explicit evaluation of these factors.

[3]The analysis presented in this paper is based on three major simplifications of the actual target price program. First, farmers receive deficiency payments based not on actual yields but on a percentage of historic average yields so that the effective target price differs from the nominal target price. Incorporating this feature involves some additional computations but alters nothing essential in the analysis. Second, to qualify for deficiency payments, farmers must remove (set aside) certain proportions of their land from productive use. These set-asides alter input use and, hence, the shape of the supply curve. Finally, target prices are based on a moving average of production costs. Any regulation which increases costs will, thus, increase target prices in several subsequent years so that a complete analysis of its market welfare impacts will necessarily be dynamic. Incorporation of these aspects is beyond the scope of this paper and will be addressed in further work.

REFERENCES

Collins, Keith and Evans, Sam, "Participation Incentives and Supply Effects of the 1982 Rice Average Reduction Program," Rice Outlook and Situation, Mar. 1982, pp. 9-12.

Gallagher, Paul and Green, Robert C., "A Cropland Use Model," ERS Staff Report No. AGES840410, Washington, D. C.: U. S. Department of Agriculture, Nov. 1984.

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

______, "Policy Options for Grains," in Gordon C. Rausser and Kenneth R. Farrell (eds.) Alternative Agricultural and Food Policies and the 1985 Farm Bill, Berkeley: Giannini Foundation of Agricultural Economics, 1984, 81-99

Grant, Warren R., Beach, John and Lin, William, "Factors Affecting Supply, Demand and Prices of U. S. Rice," ERS Staff Report No. AGES84083, Washington, D. C.: U. S. Department of Agriculture, Oct. 1984.

Grant, Warren R. and Hoskin, Roger L., "Economic Relationships of U. S. Sorghum Demand and Price," ERS Staff Report No. AGES831220, Washington, D. C.: U. S. Department of Agriculture, July 1984.

Just, Richard E., "Automatic Adjustment Rules for Agricultural Policy Controls," Berkeley: University of California, 1985 (draft of book).

National Academy of Sciences, Pest Control for Corn and Soybeans, Washington, D. C., 1983.

Townsend, Terry, Internal Estimates of Cotton Demand Elasticities, Washington, D. C.: U. S. Department of Agriculture, Feb. 1985.

Townsend, Terry, Skelly, Carol and Sronce, Phil, "Outlook for Participation in the 1985 Upland Cotton Program," Cotton and Wool Situation and Outlook, Dec. 1984, pp. 15-20.

U. S. Department of Agriculture, Agricultural Statistics, Washington, D. C., 1983.

Wallace, T. D., "Measures of Social Costs of Agricultural Programs," Journal of Farm Econ., Dec. 1962, 44, 580-94.

Zilberman, David, "Technological Change, Government Policies, and Exhaustible Resources," American Journal of Agricultural Economics, Dec. 1984, 66, 634-40.