Title
The Simple Analytics of Price Supports in the Context of International Trade

Authors
Berck, Peter
Schmitz, Andrew

Publication Date
1981-11-01

Working Paper No. 171 Rev.

THE SIMPLE ANALYTICS OF PRICE SUPPORTS IN THE CONTEXT OF INTERNATIONAL TRADE

by

Peter Berck and Andrew Schmitz

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
November, 1981

THE SIMPLE ANALYTICS OF PRICE SUPPORTS IN THE CONTEXT OF INTERNATIONAL TRADE

Peter Berck and Andrew Schmitz

Price supports have been commonplace in agricultural policy for the last five decades. Their effects have also been analyzed in several studies. For example, Wallace, using a welfare economics framework, concluded that the price-support programs proposed by Cochrane and Brannan lead to welfare losses. However, when analyzing the effect of government programs, it is insufficient to include only price supports. Government policy includes many instruments such as price supports, acreage controls, and government-held stocks which interact with each other. In this regard, much of the economic analysis of commodity reserve policy (Just <u>et al</u>.) is deficient since reserves are considered without including policy variables such as price supports. Also, the analyses of the effects of price instability and the use of policy instruments to deal with it (for example, the early work by Massell) have a major shortcoming in that they deal with price instability rather than with price uncertainty. Lastly, the work, for example, by Schuh on the effects of exchange rates on U. S. agriculture draws out the effects of exchange-rate policy on the need for government policies such as price supports (e.g., an overvalued exchange rate reduces farm income since prices are depressed; hence, the need for price supports). It does not consider how the growth in the export component of U. S. agriculture can affect the choice and effectiveness of domestic policy instruments aimed at supporting farm income.

The purpose of this paper is to discuss the effects of price supports in the context of an environment which contains these in addition to such instruments as farmer-held reserves. Uncertainty is incorporated explicitly as is the international trade sector. Propositions are derived concerning the choice of policies to support farm income at a given level. We demonstrate how these policies change as international trade becomes a growing percentage of total domestic production.

A Historical Perspective

In order to motivate the discussion in the following sections which extend the theoretical development to this point, data are presented in Tables 1 and 2 to reflect the changing nature of U. S. agriculture and agricultural policies. Table 1 gives acreage diversion figures for 1948 through 1979 and corn and wheat stocks for the same period. Prior to 1956, there was no acreage diversion program. However, by the end of 1955, corn and wheat stocks combined totaled over 2 billion bushels. The period of the 1960s witnessed, also, a large build-up of grain stocks even though acreage was diverted out of agricultural production. For example, in 1962, wheat and corn stocks approached 3 billion bushels in spite of the fact that a record 64.7 million acres had been diverted out of agricultural use. The period of the 1970s saw a drastic change. Stocks were reduced, and the land initially diverted out of agricultural use was brought back into production. In addition, the government got out of the storing business. Prior to the 1970s, the Commodity Credit Corporation owned and provided storage for the largest portion of corn and wheat stocks on hand.

Table 2 gives data on price supports for wheat and corn for 1948 through 1979. Also, market prices are given in both real and nominal terms along with export subsidy payments and total government payments. The data clearly show how the 1970s were markedly different from the 1960s, for example. Government

TABLE 1

Total Acreage Diversion and Corn and Wheat Stocks
United States, 1948–1979

Year	Total acreage diversion[a]	Stocks						
		Corn[b]			Wheat[c]			
		Commodity Credit Corporation owned	Private	Total	Commodity Credit Corporation owned	Under loan	Private	Total
	1	2	3	4	5	6	7	8
	million acres	million bushels						
1948	d	0	123	123	0	.8	195.1	195.9
1949		67	746	813	227.3	16.3	63.8	307.3
1950		335	509	844	327.7	33.5	63.5	424.7
1951		403	337	740	196.4	11.2	192.3	399.9
1952		291	196	487	143.3	11.6	101.1	256.6
1953		235	533	769	470.0	22.5	113.0	605.5
1954		353	567	920	774.6	75.3	83.6	933.5
1955		681	354	1,035	975.9	14.1	46.2	1,036.2
1956	13.6	818	347	1,165	950.7	28.9	53.9	1,033.5
1957	27.9	932	487	1,419	823.0	12.8	72.1	908.9
1958	27.1	1,101	368	1,469	834.9	18.2	28.3	881.4
1959	22.5	1,153	371	1,524	1,146.6	96.1	52.4	1,295.1
1960	28.7	1,286	501	1,787	1,195.4	92.0	26.0	1,313.4
1961	53.7	1,327	689	2,016	1,242.5	125.4	43.4	1,411.3
1962	64.7	888	765	1,653	1,096.6	95.0	130.4	1,322.0
1963	56.1	810	555	1,365	1,082.5	96.6	16.1	1,195.2
1964	55.5	814	723	1,537	828.9	62.6	9.9	901.4
1965	57.4	522	625	1,147	607.7	74.7	134.9	817.3
1966	63.3	93	749	842	262.1	78.3	194.8	535.2
1967	40.8	136	690	826	123.6	77.7	223.7	425.0
1968	49.3	179	990	1,169	102.3	220.9	216.2	539.4
1969	58.0	290	828	1,118	162.7	453.0	202.9	818.6
1970	57.1	197	808	1,005	301.2	436.3	147.4	884.9
1971	37.2	97	570	667	369.9	199.7	161.9	731.5
1972	62.1	156	971	1,127	367.4	347.0	148.7	863.1
1973	19.6	4	704	708	144.1	67.4	226.9	438.4
1974	2.7	0	484	484	18.9	.2	228.3	247.4
1975	2.4	0	361	361	1.3	1.0	324.3	326.6
1976	2.1	0	399	399	0	665.2		665.3
1977	0	0	884	884	0	1,112.2		1,112.2
1978	0	10	1,094	1,104	45.7	1,131.0		1,176.7
1979	0	95	1,190	1,286	50.2	874.5		924.7

[a]Total cropland withheld under specified programs.

[b]Includes total government loans (original and reseal).

[c]Data for years 1948–1975 based on year beginning July 1; for years 1976–1979, year beginning June 1.

[d]Blanks indicate zero.

Sources:

Col. 1: U. S. Department of Agriculture, Agricultural Statistics, 1972, Table 755, p. 637; and ibid., 1976, Table 709, p. 518.

Cols. 2–4: Ibid., 1972, Table 47, p. 43; and ibid., 1980, Table 41, p. 31.

Cols. 5–8: Ibid., 1972, Table 11, p. 12; ibid., Table 4, p. 4; and U. S. Economics, Statistics, and Cooperative Service, Wheat Situation, May 1979–May, 1980, Table 1, p. 2.

TABLE 2

U. S. Farm Export Subsidies, Government Payments, and Market and Support Prices for Corn and Wheat, 1948-1979

Year	Export subsidies	Government payments	Market price		Support price[a]	
			Corn	Wheat	Corn	Wheat
	1	2	3	4	5	6
	million dollars		dollars per bushel			
1948	0	257	1.28	1.98	1.44	2.00
1949	0	185	1.24	1.88	1.40	1.95
1950	0	283	1.52	2.00	1.47	1.99
1951	0	286	1.66	2.11	1.57	2.18
1952	0	275	1.52	2.09	1.60	2.20
1953	0	213	1.48	2.04	1.60	2.21
1954	0	257	1.43	2.12	1.62	2.24
1955	0	229	1.35	1.98	1.58	2.08
1956	0	554	1.29	1.97	1.50	2.00
1957	0	1,016	1.11	1.93	1.40	2.00
1958	1,252.0	1,089	1.12	1.75	1.36	1.82
1959	1,260.0	682	1.05	1.76	1.12	1.81
1960	1,304.0	702	1.00	1.74	1.06	1.78
1961	2,204.9	1,493	1.10	1.83	1.20	1.79
1962	2,237.5	1,747	1.12	2.04	1.20	2.00
1963	2,107.6	1,696	1.11	1.85	1.25	2.00
1964	2,339.7	2,181	1.17	1.37	1.25	2.00
1965	2,179.9	2,463	1.16	1.35	1.25	2.00
1966	1,965.3	3,277	1.24	1.63	1.30	2.57
1967	1,560.2	3,079	1.03	1.39	1.35	2.61
1968	1,404.6	3,462	1.08	1.24	1.35	2.63
1969	1,106.9	3,794	1.16	1.25	1.35	2.77
1970	1,230.9	3,717	1.33	1.33	1.35	2.82
1971	1,335.0	3,145	1.08	1.34	1.35	2.93
1972	1,361.3	3,961	1.57	1.76	1.41	3.02
1973	1,448.1	2,607	2.55	3.95	1.64	3.39
1974	1,001.6	531	3.03	4.09	1.38	2.05
1975	1,224.0	807	2.54	3.56	1.38	2.05
1976	1,123.0	734	2.15	2.73	1.57	2.29
1977	1,521.0	1,819	2.02	2.33	2.00	2.90
1978	1,542.0	3,030	2.25	2.98	2.10	3.40
1979	b	1,375	2.52	3.82	2.20	3.40

[a]Represents the average loan rate plus any direct price-support payment. For wheat, it is the value of the domestic marketing certificate received by participants in the program. Also, since 1974, the figures represent target prices.

[b]No data available.

Sources:

Col. 1: U. S. Department of Agriculture, Agricultural Statistics, 1959, Table 822, p. 597; 1960, Table 817, p. 598; 1961, Table 815, p. 589; 1962, Table 818, p. 695; 1964, Table 823, p. 597; 1967 Table 830, p. 712, and Table 831, p. 712; 1970, Table 816, p. 588; 1972, Table 822, p. 703, and Table 823, p. 703; 1974, Table 790, p. 574; 1976, Table 776, p. 572, and Table 777, p. 572; and 1979, Table 780, p. 563.

Col. 2: Ibid., 1972, Table 682, p. 562; and ibid., 1980, Table 652, p. 460.

Cols. 3 and 4: Idem, 1978 Feed Grain, Wheat, Upland Cotton and Rice Programs, p. 52; ibid., p. 62.

Cols. 5 and 6: Idem, Agricultural Statistics, 1957, Table 678, p. 568; ibid., 1967, Table 685, p. 560; and ibid., 1980, Table 651, p. 458.

payments were reduced, export subsidies were eliminated, and market prices rose substantially above price-support levels.

In the following sections, we attempt to model some of the key features of agricultural policy which existed in the 1950s, 1960s, and 1970s. For example, the data in Table 1 clearly reflect the farmer-held reserve plan put into effect in the Agricultural Act of 1977. However, even though the type of policies changed throughout this time period, price supports, as the tables suggest, existed throughout the entire period.

Traditional evaluations of agricultural stabilization programs do not clearly distinguish between decisions taken before and after the state of nature--the weather--is known. The early work of Oi notes that expected profits as a function of random prices are always at least as great as profits at expected prices. (Proof: Jensen's inequality and the convexity of the profit function.) Oi's conclusion that stabilization never benefits farmers ignores the sources of agricultural uncertainty and leads to the prediction that farmers have their largest crops when prices are high. By building a simple equilibrium model, Massell (and Samuelson) was able to reverse Oi's finding against stabilization programs. Massell argues that there is a supply curve appropriate to each state of nature and equilibrium prices and that quantities are determined by the intersection of these *ex post* supply curves and a linear demand schedule. With only two states of nature, simple geometry suffices to show that government stabilization of price through storage increases "producer surplus." The analysis is flawed by the inability of an *ex post* supply curve to yield information on true rents or surpluses (Currie, Murphy, and Schmitz). The planting decision--and most of the costs--comes before the state of nature is known, and this is what distorts the meaning of an *ex post* supply curve.

By explicitly considering the farmer's planting decisions, it is not difficult to derive the true or planning supply curve. Let output, Q, be a function, y, of acreage planted, A, times an ex ante uncertain term, ϵ, representing weather: $Q = y(A)\ (\epsilon + 1)$, where $E\ \epsilon = 0$ and $\epsilon > -1$. Expected profit, $E\ \pi$, as a function of random prices, p, and opportunity cost of land r(A) is found by solving

$$\max_{A}\ E\ p(\epsilon + 1)\ y(A) - r(A)$$

for the maximizer, A*. The expression $E(p + \epsilon p)$ is a certainty equivalent or planning price, pp, and it is also expected revenue divided by expected quantity. One can then write the supply problem as the certainty equivalent problem,

$$\max_{A}\ pp\ y(A) - C(A)\ .$$

The usual marginal conditions yield the true supply curve, S(pp). The remaining task is to find the planning price curve and solve for equilibrium prices and quantities. In the linear demand two states-of-nature case so often examined in the literature, the planning price curve is simple to derive. Let $p(Q) = a - bQ$ be the demand curve and ϵ take on the values ϵ^* and $-\epsilon^*$ with equal probability. Straightforward calculation gives

$$pp(Q) = E(p + p\epsilon) = a - b(1 + \epsilon^{*2})\ Q.$$

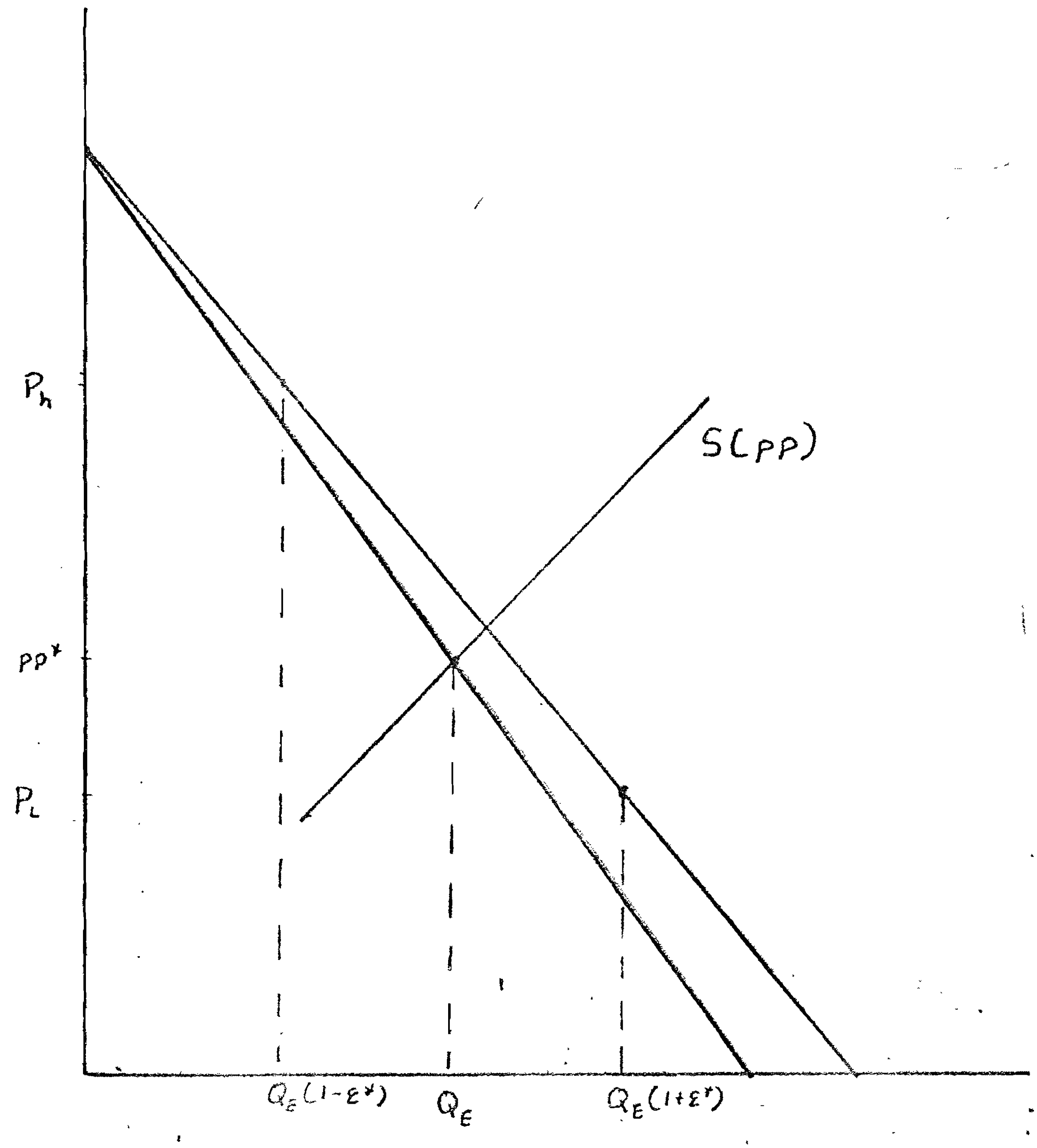
Thus, the planning price curve is always below the linear demand curve. (Just et al. give conditions on demand curves for producers to prefer stabilization; these conditions are also sufficient for planning price to be below demand.)

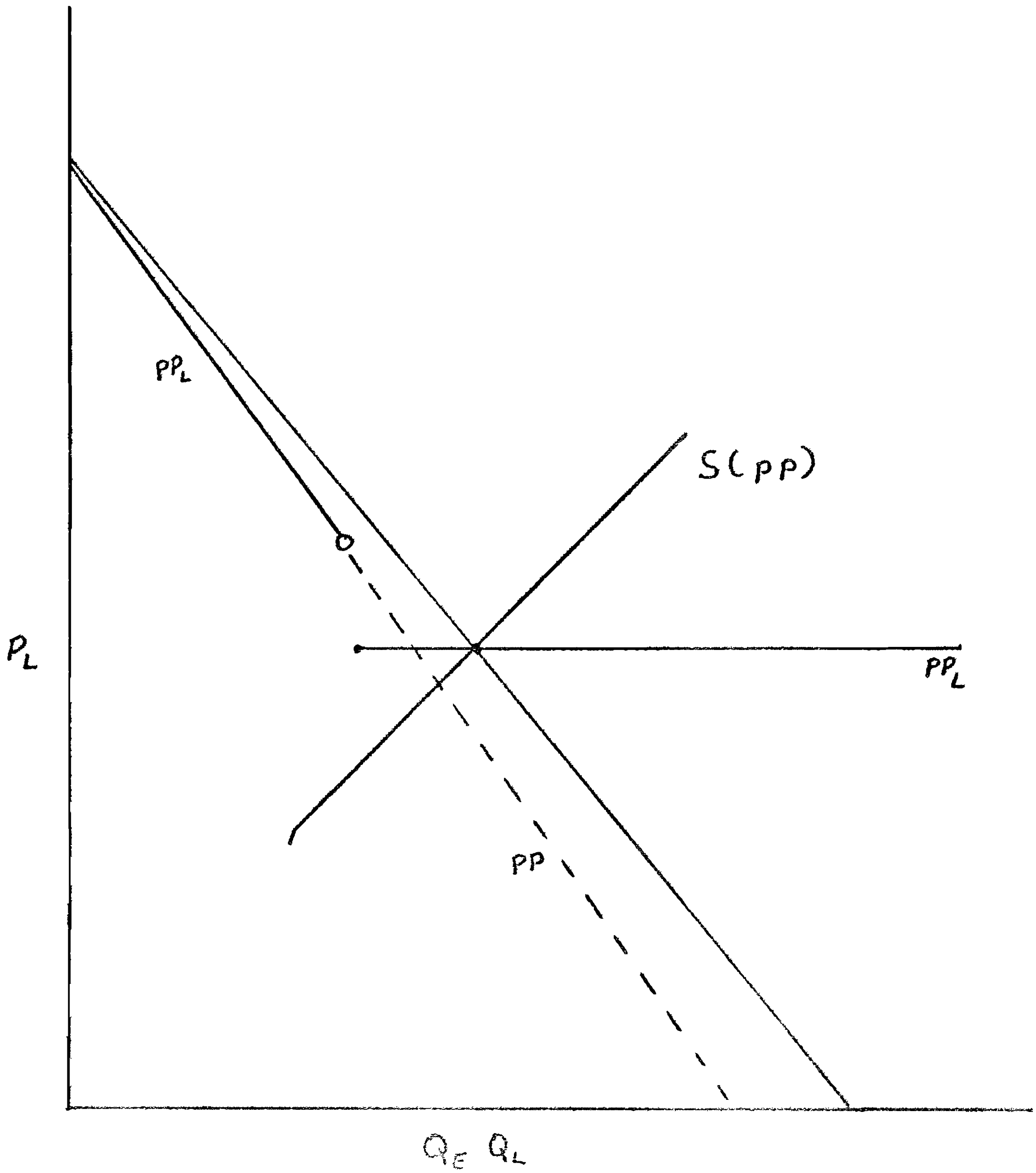
Figure 1 shows a typical equilibrium, where $S(pp)$ intersects $pp(Q)$ at Q^*. Actual prices are P_h and P_L with equal probability. Now, we will use this model to analyze the U. S. agricultural policy in the post-World War II period.

In the 1950s and 1960s, the price of grain was the government loan rate which was set so high that large stocks accumulated even with export subsidies, acreage limitations, and PL-480 food aid. Many causes are cited for the large stocks including technical change, yield price response, and reduced uncertainty. Analysis of the planning supply curve and planning price curve adds another reason to the list: stabilizing prices with a nonrecourse loan program increases planning price, and the producers simply responded to that higher price.

The analysis of the loan program requires deriving an appropriate planning price curve. Let P_L be the loan rate. If so little acreage is planted that the market price is always higher than the loan rate, then the planning price curve with loan rate, $pp_L(Q)$, is the same as it was without the loan rate. In symbols, when $Q \leq (a - P_L)/b(1 + \epsilon^*)$, $pp(Q) = pp(Q)$. As soon as the loan rate becomes effective, prices stabilize at P_L because there is (on average) always at least enough released storage to drive prices down to the loan price in poor crop years and the government supports the price through purchases (at P_L) in good crop years. Figure 2 depicts the equilibrium, Q_L. The government alternately buys and sells $Q_L \epsilon^*$, and the price remains stable at P_L.

Figure 2 also contains the comparison between the no-policy equilibrium, Q_E, and the loan program equilibrium, Q_L. The intersection of the supply and pp curve--shown as a dashed line--is at a lower quantity than the stabilized supported equilibrium, Q_L. Actually, the diagram has been


P_h
PP*
P_L
S(PP)
Q_E(1-ε*)
Q_E
Q_E(1+ε*)


PP_L
S(pp)
P_L
PP_L
PP
Q_E Q_L

constructed to show a stronger point: the supply, pp_L, and demand curve have a common intersection so expected storage is zero. Contrary to the results of Massell, the diagram shows that, even with linear demand curves, the government cannot stabilize consumption at Q_E and price at $P = a - bQ_E$ by buying and selling $Q_E\varepsilon^*$. The benefits of stablization engender their own supply response, and equilibrium supply is $Q_L > Q_E$. Alternatively, the government could stabilize price at $pp(Q_E)$, its average. Such price stabilization would require average imports of $Q_E - [a = pp(Q_E)]/b$, again showing that stabilization of price and quantity both at their previous means is impossible.

To sum up, a loan program implies stabilization, stablization implies increased planning price, and increased planning price implies a supply response.

Since the government placed support prices above equilibrium as well as getting a stabilized supply response, it had to purchase and hold large stocks. To avoid the costly side effects of the loan program, the government resorted to acreage controls (in 1956), PL-480 giveaways (in 1958) and export subsidies (in 1958). Acreage controls simply shift the supply curve upwards, and giveaways just avoid the storage (but not the purchase) costs. Export subsidies, however, have real potential for treasury savings. If the demand by foreigners is elastic and grain has already been stored until it is redundant (has zero stock price), then export subsidies can save treasury costs, a point we will elaborate on later.

Almost immediately after World War Two, Secretary Brannan proposed supporting perishable commodities with deficiency payments rather than non-recourse loans. Brannan's plan would have ended the government's practice of buying and destroying potatoes and the specter of the destruction of yet other crops. Although other parts of Brannan's proposal and the general political situation doomed Brannan's plan (see Benedict, p. 484), the deficiency payment idea was widely analyzed and finally implemented in the post-Russian-wheat-deal era. Deficiency payments alone did not constitute all of farm price policy. A "farmer held reserve" and even a traditional loan policy were used in conjunction with deficiency payments. These policies and the changing world situation lead to a much larger price uncertainty.[1] This section describes these policies and their interactions.

A pure deficiency payment plan consists of setting a target price, P_T, and paying farmers the difference between the market price and the target price whenever the market price is less than the target price. This payment from the treasury is called a deficiency payment. The average revenue curve, $pp_T(Q)$, corresponding to this policy, has three segments. For, when Q is quite low, $Q \leq Q_L$, where

$$Q_L = \frac{a - P_T}{b(1 + \varepsilon^*)}$$

[where $pp_T(Q)$ equals $pp(Q)$], and the program is never effective. For higher Q, the target prices are effective only some of the time. Letting

$$Q_H = \frac{a - P_T}{b(1 - \varepsilon^*)}$$

one finds that for $Q_L < Q \leq QH$,

$$pp_T(Q) = \frac{1}{2} (1 - \varepsilon^*) [a - bQ(1 - \varepsilon^*)] + \frac{1}{2} P_T (1 + \varepsilon^*)$$

which on substituting for P_T gives

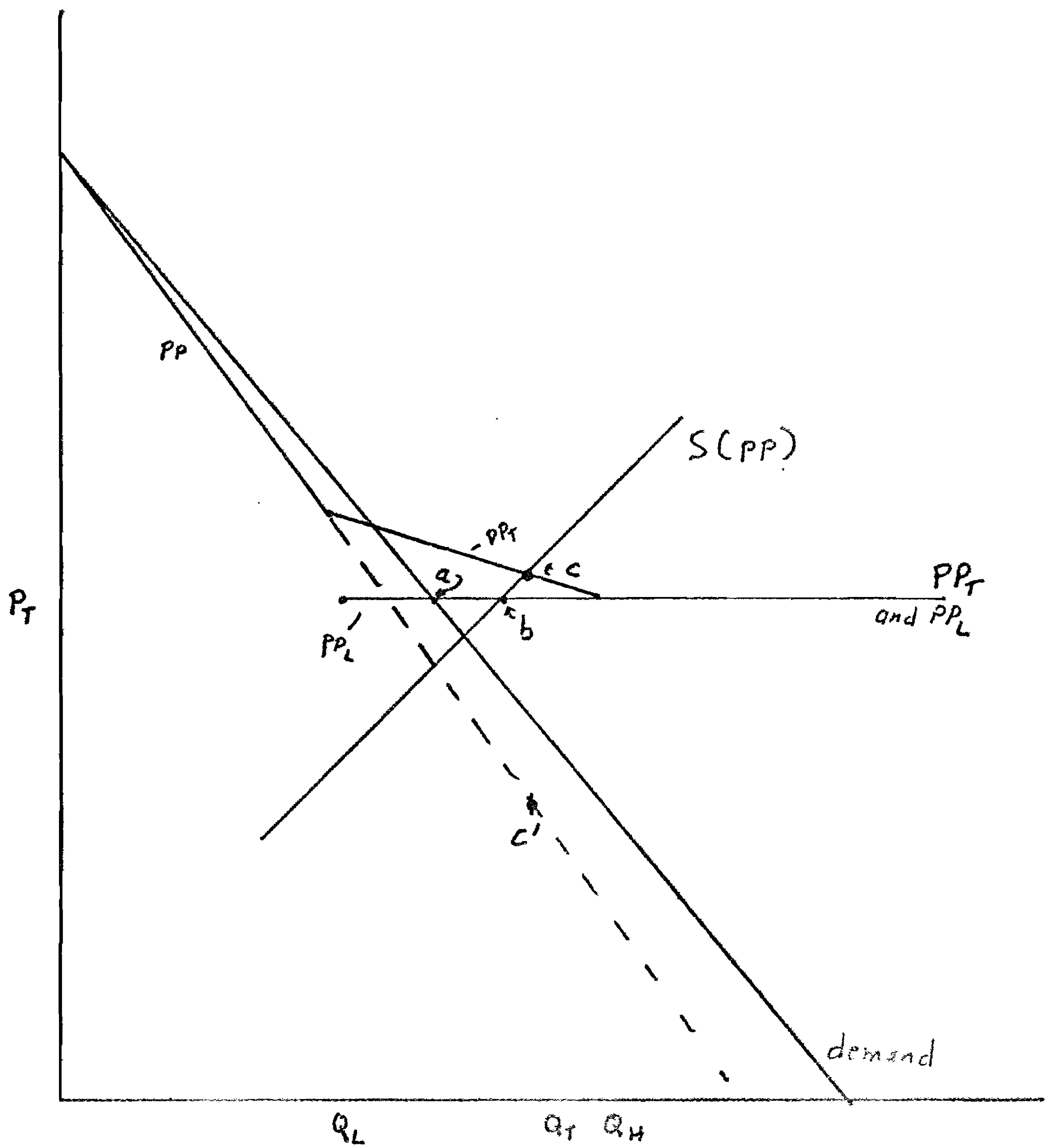
$$pp_T = pp(Q) + 1/2(Q - Q_L)\ b(1 + \varepsilon^*)^2.$$

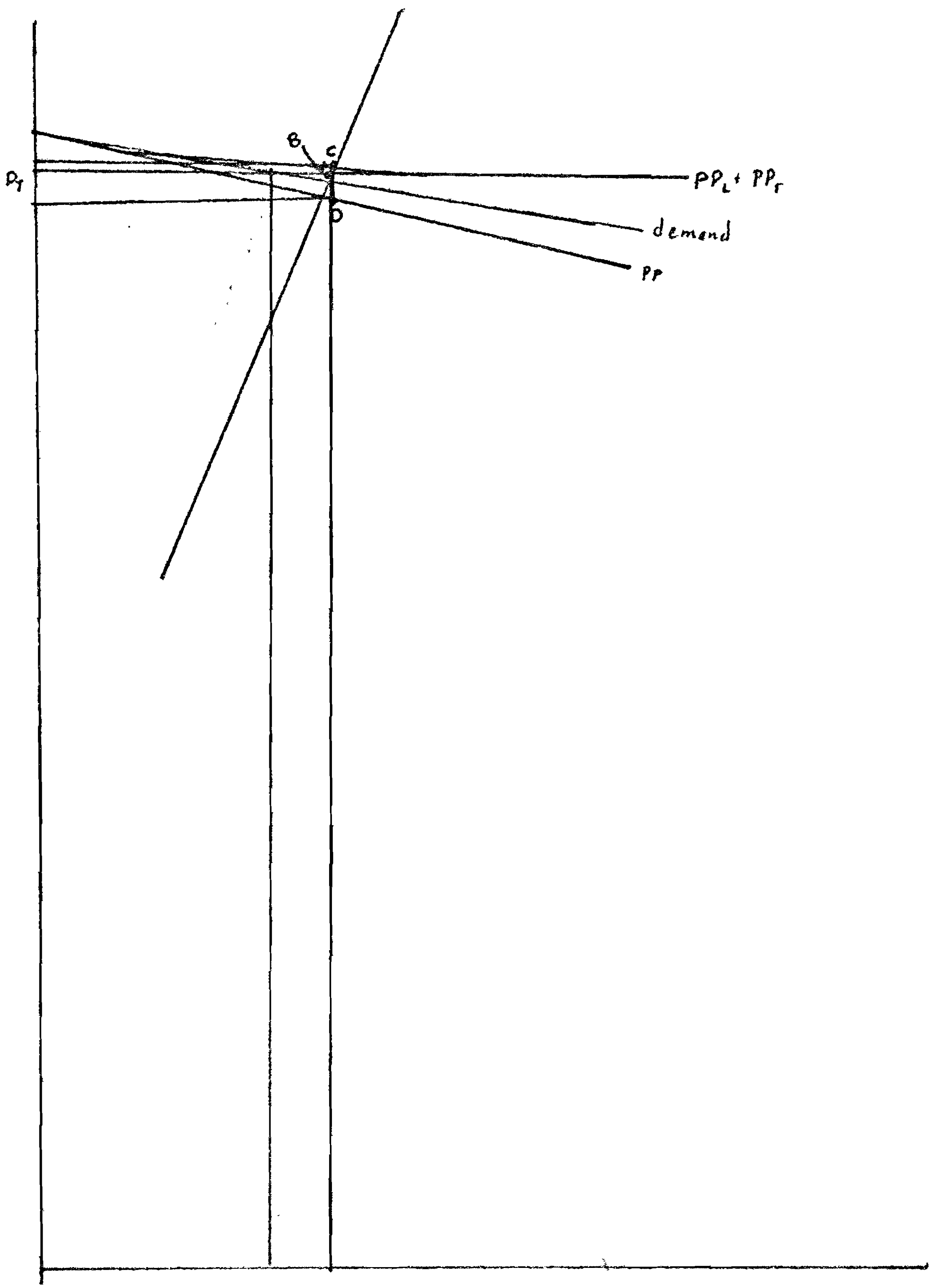
This regime, where delivery payments are made only in some years, is not covered by Wallace's early analysis. Finally, for $Q > Q_H$, the target prices are always effective and $pp_T(Q) = P_T$ which is precisely the case treated by Wallace. Figure 3 illustrates a pure deficiency payment plan.

Included in the figure as a dashed line is the portion of pp_L not coincident with pp_T. Since pp_T is nowhere below pp_L, producers prefer a target price plan to a loan plan. And, for the same reason, output expands more under a target price plan than under a loan plan.

As Brannan's original critics pointed out, the costs of deficiency payments can far exceed those of loan payments. Assuming that average excess storage is worthless, the costs of a loan plan, c_L, are P_L (b - a) while the costs of deficiency payments are $Q_T(P_T - c')$ where c' is the planning price for Q_T. As the diagram is drawn the latter are larger, but the conclusion could easily be reversed if the diagram were differently drawn. In particular, commodities such as wheat which are thought of as being in equilibrium on the inelastic portion of the linear demand curve require deficiency payments on large output quantities. They are poor candidates for a deficiency payment plan. Butter, on the other hand, would have a higher elasticity, require subsidization of a smaller quantity, and the storage would cost relatively more to purchase. Figure 4 illustrates such a case. Deficiency payments are P_TCDE which is obviously less than loan payments FABG. Thus, a deficiency payment plan could involve a lower treasury cost than a loan plan.

In addition to price-support mechanisms, the government may subsidize exports. With a loan plan in place, an export subsidy decreases treasury costs


PP
S(PP)
PPT
c
a
PPT
and PPL
PT
PPL
b
c'
demand
QL
QT QH


B
C
p_T
D
$PP_L + PP_r$
demand
PP

if and only if it increases revenues from exports. With a deficiency payment plan in place, an export subsidy may decrease treasury costs even if it decreases payments by foreigners.

Consider the simple case where deficiency payments are made every year. Let $F(P) = f - gP$ be foreign and $D(P) = a - bP$ be domestic demand. With an export subsidy of t, the market-clearing domestic price is the solution of

$$F(P - t) + D(P) = Q(1 + \varepsilon)$$

for the random variable P. In particular,

$$P = \frac{a + f - Q(1 + \varepsilon) + gt}{g + b} .$$

Average treasury costs, C_T, are average farm revenue, $Q_T P_T$, less expected domestic and foreign consumer outlays:

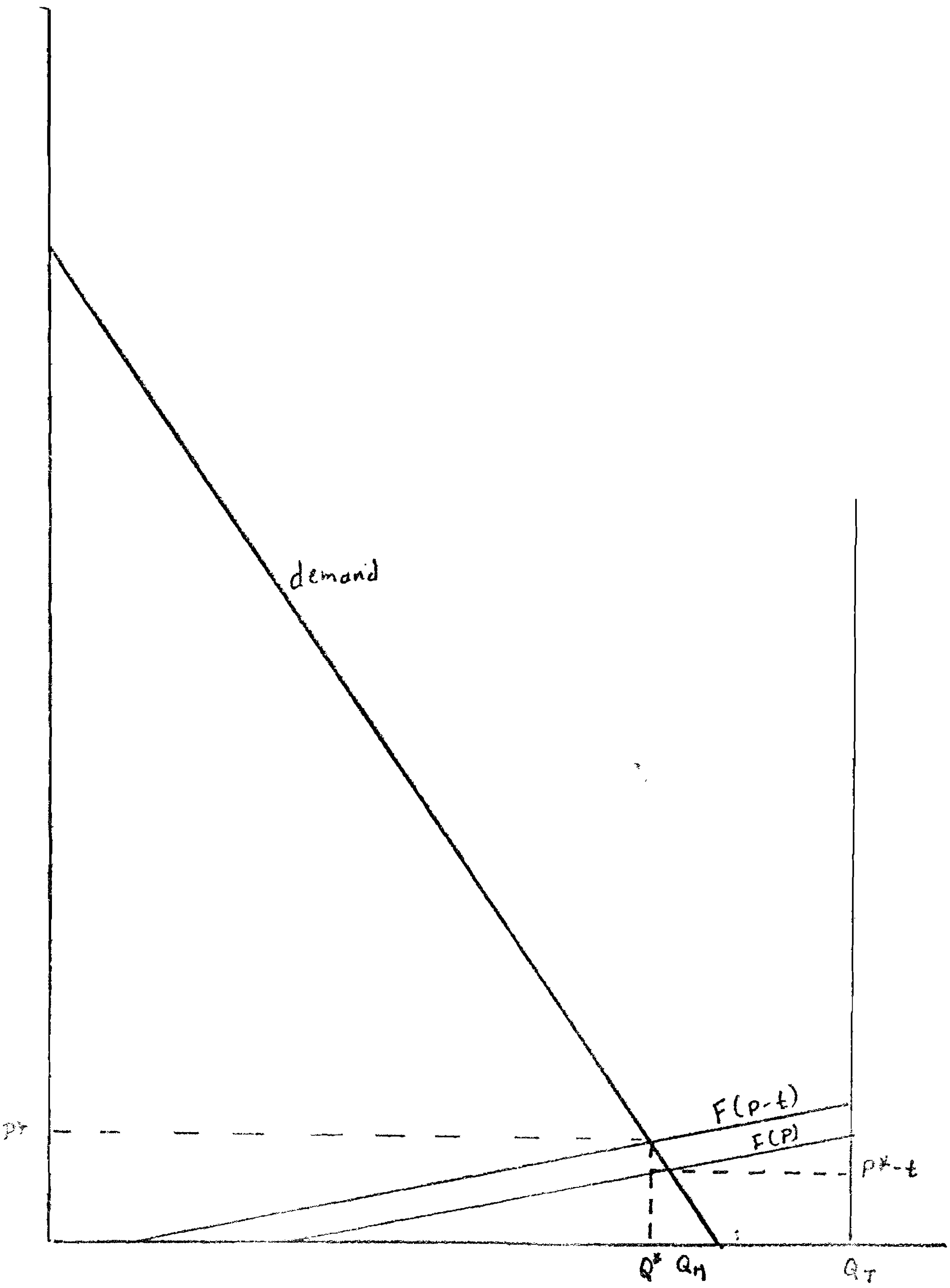
$$C_T = Q_T P_T - E[(p - t)\, F(p - t) + p\, D(p)].$$

The incidence of an export subsidy is

$$\frac{dC_t}{dt} = E \quad \frac{dP}{dt} - 1 \quad F + (P - t)\frac{dF}{dP} \quad + \quad D(P) + P\frac{dD}{dP} \quad \frac{dP}{dt} .$$

Since dP/dt and dF/dP are nonstochastic and F and D are linear, a certainty equivalent of dC_T/d_t is just the expression in brackets evaluated at $\varepsilon = 0$. Figure 5 shows a target price plan and loan plan in a certainty setting. As drawn, the export subsidy reduces the quantity in the domestic market by $Q_M - Q^*$ which gives a large revenue gain since the elasticity of domestic demand is quite low. The revenue change from the foreign market is nil since the demand elasticity is near unity.

fig 5



The change in treasury costs is $(P_M - P^*)Q_T - t(Q_T - Q^*)$ and, in this case, it is negative. By way of comparison, the change in the cost of a loan program, $P_T(Q_T - Q_L)$ is zero, since at the support price there is no foreign demand.

An exogenous growth in demand, such as that of the early 1970s, reduces the treasury costs of a target price plan even more effectively than do export subsidies. Reinterpreting Figure 5, if the foreign demand curve has expanded by gt, then P* is the new comparison price, and the expected savings are $(P^* - P_M)\ Q_T$. More generally, an increase in demand decreases treasury costs in any of the models in this paper.

Where treasury costs were the overriding consideration in choosing an export subsidy policy in the 1950s, food security issues have helped shape the policy of the late 1970s. The farmer-held reserve was seen as a method of stabilizing prices both for American consumers and for foreign customers. In fact, the size of the reserve was to be limited unless the United States were to form a commitment to an international grain reserve agreement. This aspect of trade policy was not, as the following section will make clear, in farmers' interests.

With a target-price plan and possibly export subsidies already in effect, producers are not likely to favor further price stabilization. The farmer-held reserve and the setting of a loan price are examples of further stabilization policy which we will examine.

Before proceeding to a rigorous analysis of a reserve policy, the following trade data are important. Table 3 illustrates the growth in U. S. agricultural trade. Between 1965-66 and 1978-79, grain exports in terms of quantity expanded by roughly 10 percent while cotton increased by more than

Table 3. Proportion of Yearly Production of Major U. S. Agricultural Products Exported (Percent of Total Quantity), Selected Years

	1965-66	1970-71	1974-75	1978-79
	...................percent........................			
Grains[a]	26.1	20.1	33.4	36.5
Soybeans	28.9	36.9	35.3	38.1
Cotton	31.1	33.7	34.9	53.9[b]

[a]Includes wheat, rice, corn, rye, oats, sorghum, and barley.

[b]1978 only.

Source: Sarris, Alexander H. and Andrew Schmitz, "Toward a U. S. Agricultural Export Policy for the 1980s," Amer. J. Agric. Econ., forthcoming.

20 percent. It is apparent that the total demand curve for U. S. agricultural products has been growing (i.e., the combined demand by U. S. consumers and importers has been shifting to the right). Also, partly due to the growth in export demand, the total demand curve facing U. S. producers has become more price elastic (see Burt, Koo, and Dudley). As will become apparent, these phenomena have important implications for a combined target price-farmer held reserve policy.

The farmer-held reserve program is a subsidy to the holding of stocks, part of which is withdrawn when the price rises to 170 percent of the loan rate or if the farmer elects to sell before the price reaches 140 percent of the loan rate. (Figures are for the 1979 crop year). We will model it simply as a subsidy, t, to be subtracted from the storage costs, c, of holding grain.

Equilibrium reponse to policy depends on two sets of agents, storers and producers. Producers will behave, as before, maximizing profits without predictive ability. Since producers own land, a factor in fixed supply, they earn rents. Storers, however, are modeled as being in a constant-cost industry without barriers to entry; thus, they earn no profit. For algebraic simplicity, we assume they have perfect information about the next crop before they commit to storage and, further, that bad crops follow good in alternating fashion. This assumption is heroic, but the general conclusions do not change if the world is assumed to have two periods and the storers' rational expectations.

Without uncertainty in the ordering of the good and poor crops—called instability in the literature—the profits from the storage of crops from one season to the next are:

$$\pi(z_1, Q) = z[a - bQ(1 - \varepsilon^*) - bz] - z[a - bQ(1 + \varepsilon^*) + bz] - z(c - t)$$

where z is the units stored. Since profits are zero in pure competition, the optimal storage, given output Q, will be

$$z(Q) = Q\varepsilon^* - \frac{c - t}{2b}$$

or zero, whichever is greater. Storage is clearly increasing in the government subsidy.

With no policy in effect except storage subsidies, producers clearly gain from the subsidization since

$$pp_S(Q) = a - bQ - bQ\varepsilon^{*2} + bZ(Q)\ \varepsilon^*$$

is their average revenue and is increasing in the government storage subsidy. With a target price also in place, this is no longer the case.

For convenience, assume that storage is not zero over the relevant range of outputs. The planning price curve is as usual composed of three line segments. The first segment of pp_{ST} is relevant when the deficiency payments are made in neither state of nature: $Q < Q_L = [a - P_T - 1/2(c - t)]/b$ and $pp_{ST} = pp_S$. The second segment is appropriate for higher Q: $Q_L < Q \leq Q_H = [a - P_T + 1/2(c - t)]/b$ and $pp_{ST} = pp_S + 1/2\ (Q - Q_L)\ b(1 + *)^2$. The third segment, for $Q > Q_H$ is just P_T. Obviously, pp_{ST} and pp_S are the same when the subsidy, t, is zero. Direct computation shows that the planning price curve is nonincreasing in t:

$$\frac{dpp_{ST}}{dt} = \frac{dpp_S}{dt} - \frac{1}{2}\ b(1 + \varepsilon^*)^2\ \frac{dQ_L}{dt}$$

which, on carrying out the algebra, gives

$$\frac{dpp_{ST}}{dt} = -\frac{1}{4}(1 + \varepsilon^*)^2$$

for Q between Q_H and Q_L. Outside this range of Q,

$$\frac{dpp_{ST}}{dt} = 0 \text{ for } Q > Q_H$$

and

$$\frac{dpp_{ST}}{dt} = \frac{dpp_S}{dt} > 0 \text{ for } Q \leq Q_L.$$

Thus, in the leading case--that of target price above market price only some of the time--producers oppose storage subsidies.

Price Supports and Farmer-Held Reserves

To consider the analysis further, the case is presented in Figure 6 where prices fluctuate in the inelastic portion of the demand curve. The stable price is $\overline{P}$, while prices are P_2 and P_1 without storage. Suppose a price support of τ is introduced so producers receive price P_s for Q_1. At P_s, producers prefer price instability to stability (i.e., $\overline{P}$ with storage). Now introduce a government storage subsidy for producers of the cross-hatched area,[2] i.e., $\tau(Q_1\ Q_s)$. This storage will be released by producers in period 2 and will cause prices to be P_2' instead of P_2 in that period. Clearly, in period 2, total revenue will decrease due to the release of stocks. In addition, with storage, producers lose P_s abc unless support price P_s is kept. As a result, for producers as a group to participate in the program, either the storage subsidies have to be made greater or a price-support system has to be maintained. Suppose prices continue to be supported

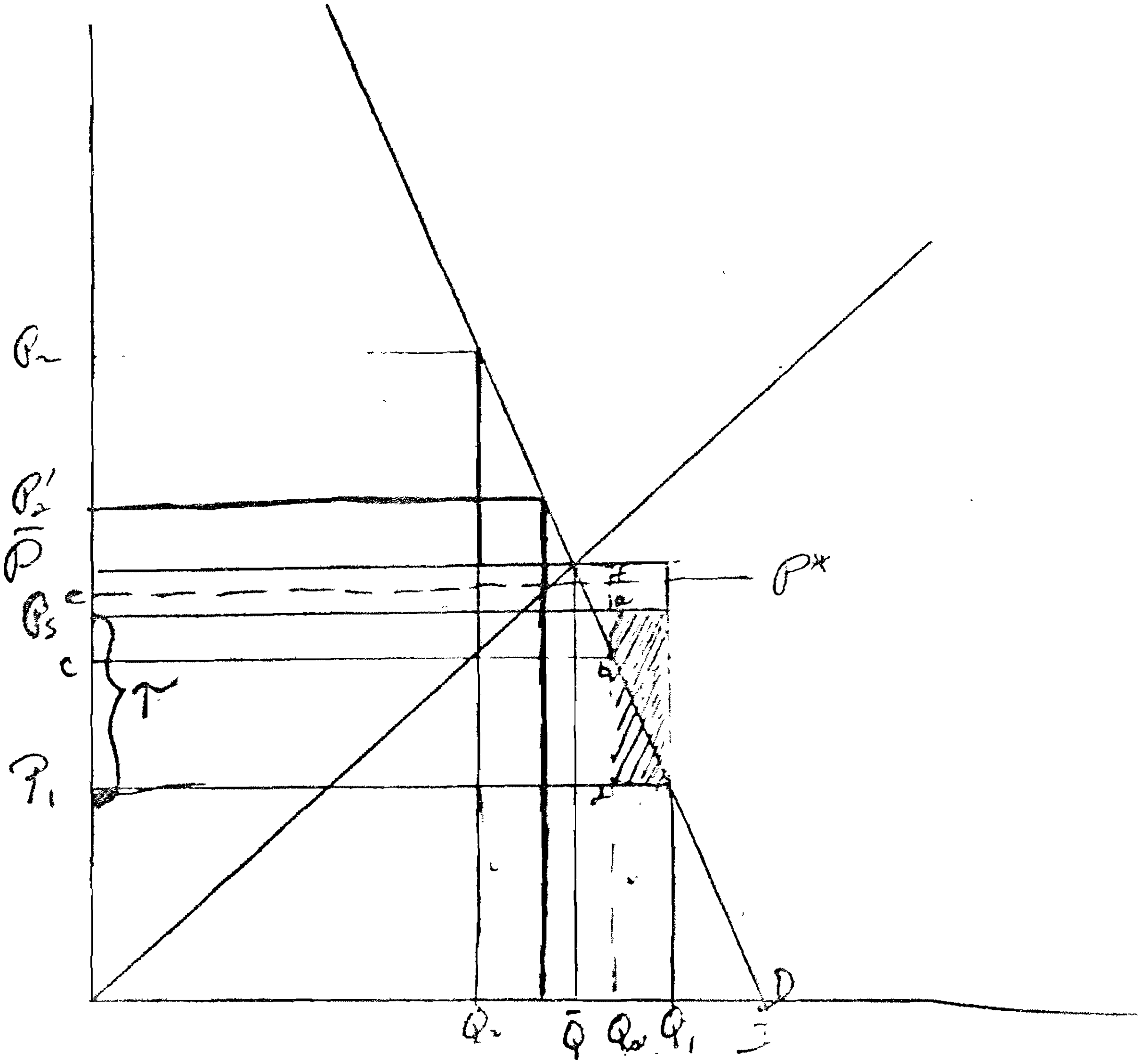


Figure 6. Price supports and farmer-held reserves (inelastic demand).

at P_s with $Q_s\ Q_1$ of storage. Clearly, producers are still worse off with farmer-held reserves than with support price P_s and no reserves. Note that, at P_s with storage by producers, the Treasury savings are P_1 cbd and P_1 versus P_s with no storage. But to make storage attractive, the government has to increase the level of support above P_s if $\tau(Q_s\ Q_1)$ is held fixed. There now exists some price-support level above P_s where instability (and no stocks) is not preferred to instability accompanied by supports and farmer-held reserves.

In the above, even though the support level has to be raised to induce farmer-held reserves, there is a Treasury savings. For example, at a support price P^* producers are better off with storage than with no storage and P_s. In addition, the Treasury saves cbd P_1 - efbc. Thus, the government can find a storage policy for farmers which can both improve their welfare and reduce Treasury costs. To do this, however, when reserves are introduced, the government has to increase the level of price supports even though it reduces the amount of support payment.

Consider now an interesting comparison in Figure 7 where the demand is price elastic. In the model, τ is set at the point where producers are indifferent between a price support of P_s with no storage or storage and complete stability at P. Suppose farm storage is subsidized by $Q_1\ Q_s(\tau)$. In this case, when $Q_s\ Q_1$ is released in period 2, total revenue increases when prices drop from P_2 to P_2'. As a result, producer welfare is increased and Treasury costs are reduced by abdc. In addition, Treasury costs could be reduced even further before producers would be indifferent between price supports and no storage or price supports and storage. In both cases, instability still exists. There are two important differences between this

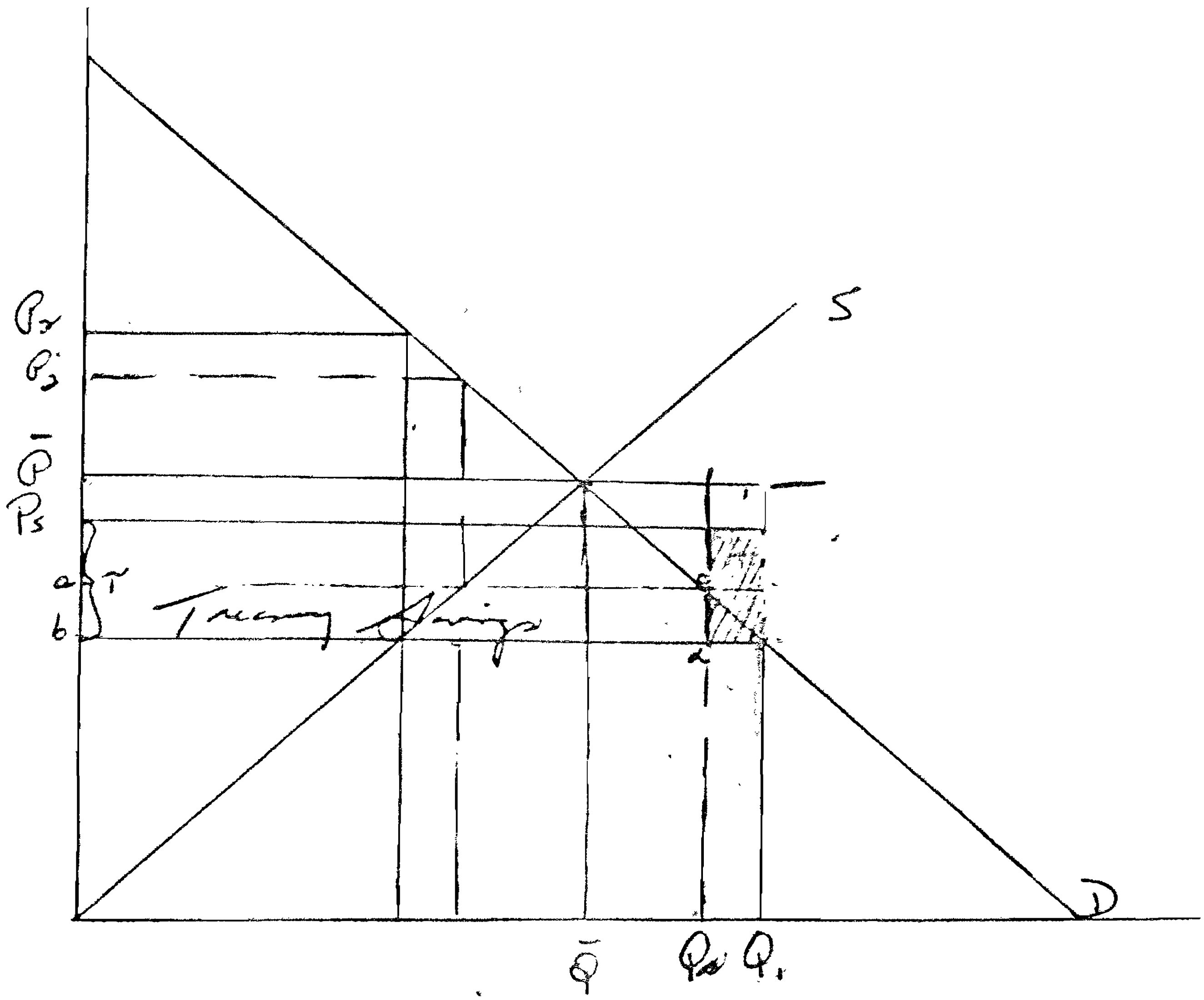


Figure 7. Price supports and farmer-held reserves (elastic demand).

case and the inelastic one presented earlier. First, the Treasury savings from farmer-held reserves (keeping producer welfare unaffected), expressed as a percentage of total support payments in the absence of reserves, is greater when the demand is price elastic. Secondly, in the price elastic case, the level of price supports does not have to be increased in order to improve welfare through farmer-held reserves and price supports above what can be achieved with price supports and no reserves.

Implications With Trade

Consider the analysis in the above section in the context of the growth of U. S. farm exports through time. The demand for U. S. farm products not only has grown due to export demand, but, also, along with the total demand (the aggregation of U. S. and foreign demand), has become more price elastic. Consider Figure 8 where D_0 is the demand for U. S. products by both domestic and foreign consumers. Prices could be stabilized at $\overline{P}$ with storage. With price supports, producers can prefer price instability to stability by the previous model. Comparing D_0 with D_1, where D_1 represents a different point in time due to the growth in demand from exports, the results of a farmer-held reserve take on added significance. As already demonstrated, the Treasury savings from a farmer-held reserve expressed in percentage terms is greater with D_1 than with D_0. This is because, at P^*, the demand is price elastic while, at $\overline{P}$, it is price inelastic.

Suppose one argues that, with the growth in trade, the variance of instability increases due to weather, exchange rates, etc. (Schuh). In this case, D_1 (with a larger variance in prices than at D_0 since now the price band would be greater than P_1^*, P_2^*) yields an even higher payoff from

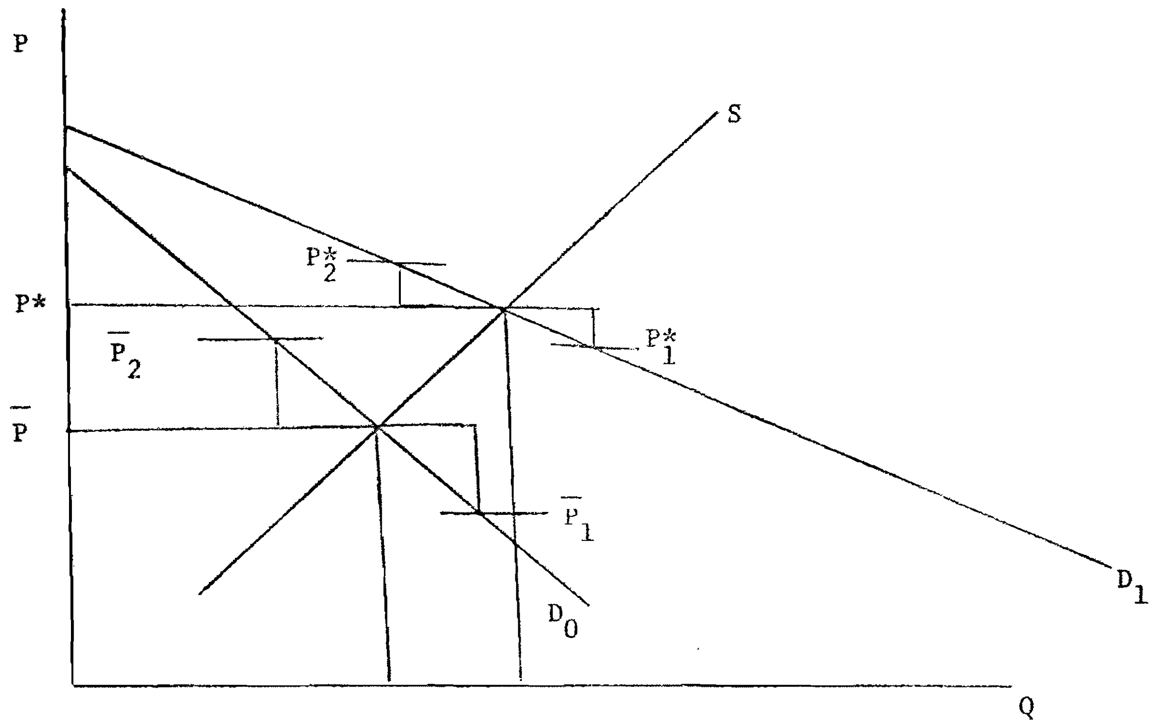


Figure 8. Growth in export demand and price supports

farmer-held reserves. As the variance of prices increases, the Treasury savings also increases by introducing both price support and reserves rather than only price supports in order to maintain a certain level of producer welfare.

Conclusions

In this paper we have tried to model agricultural price and income policy through various stages of the development of U. S. agriculture. The emphasis has been on the effects of government intervention in a simple model of uncertainty. We attempted to analyze the interaction effects of price supports and/or deficiency payments, acreage controls, stocks, and export subsidies recognizing that many other policy instruments exist in addition to these. However, to include more instruments in our framework is beyond our capabilities. Among our major results are that producers clearly prefer price instability when target prices are used to protect farmers against downside risk. Also, because of the growing importance of international trade, grain stocks increase since the profitability of holding stocks increases due to the nature of aggregate demand. Also, in this case, Treasury costs can be reduced substantially given a specified level at which farm prices are to be supported. Through the use of storage, farm income can be maintained while at the same time governments can reduce their outlays on subsidies.

Footnotes

[1]Instability is measured by change in value between present year and past year divided by the value which is greatest for the two years. An average is then taken of all percentage changes over the periods considered. This gives average degree of instability. The measure gives a downward bias to fluctuation and does not correct for trend.

	Corn	Wheat
1949-1955	.071	.043
1956-1969	.059	.078
1970-1979	.176	.166

[2]We do not consider here storage by grain trading firms. Also, we assume that all producers store in proportion to production. However, these assumptions could easily be relaxed.

References

Burt, Oscar R., Won W. Koo, and Norman L. Dudley, "Optimal Stochastic Control of U. S. Wheat Stocks and Exports," Amer. J. Ag. Econ. 62(1980):172-87.

Currie, J. Martin, John A. Murphy, and A. Schmitz, "The Concept of Economic Surplus," Econ. J. 81(1971):741-99.

Massell, Benton F., "Price Stabilization and Welfare," Quart J. Econ. LXXXIII(1969):284-98.

Sarris, Alexander H., and Andrew Schmitz, "Toward a U. S. Agricultural Export Policy for the 1980s," Amer. J. Ag. Econ., forthcoming.

Schuh, E. G., "The Exchange Rate and U. S. Agriculture," Amer. J. Ag. Econ., 56(1974):1-13.

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