WHEAT PRICE BANDS AND WELFARE: AN ANALYSIS OF STABILIZATION ALTERNATIVES

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Instability is a persistent problem in agricultural markets. During the 1970's a number of interesting refinements in the theory of stabilization have emerged, but much remains to be accomplished in applying these theories directly to policy decisions. This paper is a step in that direction. In it, several of the theoretical developments plus estimates of important parameters are integrated into a simulation model and used to evaluate selected stabilization alternatives for the U.S. wheat industry.

Three major lines of development in the theory of stabilization can be identified. The first concerns the welfare effects of carrying buffer stocks. Here the work of Waugh, Massell, and Turnovsky is most often cited. Second is the work by Behrman, Just, Trail, and Lin dealing with the effects of instability on the supply curve. We draw upon all three of these lines of development in this study. Following previous authors we make extensive use of economic surplus to measure social welfare. The issues involved in using such measures are discussed in Just (1978) and Currie, Murphy, and Schmitz.

Our objectives are to

1. Measure the effects of alternative wheat stabilization programs on selected target variables representing the welfare of U.S. farmers and consumers.[1]
2. Evaluate the welfare effects of instability that arise through both (1) divergence from equilibria and (2) long term shifts in the aggregate supply function caused by producers' risk averson and by asset fixity.
3. Realistically project outcomes for programs initiated in the present environment and operated over the next decade.
4. Estimate not only the means or expected values of the target variables, but also measures of dispersion.

This paper reports on our progress to date toward these objectives.

The approach used in this study involves constructing from estimates in previous studies a mathematical model representing the major economic relationships in the U.S. wheat economy. The model is used to simulate the effects of alternative price bounding storage programs for wheat that might be applied over the period 1979-88. In this application, simulation provides a purely deductive means for working out the implications of knowledge about economic relationships gained from other studies.

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Theory of Stabilization

Instability in the wheat industry is postulated to arise from two major sources: (1) random disturbances (shocks) in yields, acreage response and domestic and foreign demand, and (2) recurring decision errors, particularly those resulting from faulty expectations on the part of producers. The latter in combination with the random shocks contribute to cyclic behavior. The random elements in yields are primarily a weather phenomenon. Weather also plays a major part in the random fluctuations in foreign demand. The random elements in acreage response, domestic demand, and, to some extent, foreign demand represent the effects of variables excluded from the model.

Instability can impose losses upon society in at least three ways: by fostering disequilibrium between supply and demand; by shifting the supply function permanently to the left; and by accelerating inflation when price and wage levels are flexible upward but not downward. We quantify the first two effects in this study, but leave out the third because of time limitations and the difficulties involved in measuring the relation between increases in the general price level and welfare.

Previous authors concerned with instability have considered two types of disequilibrium--failure to carry optimal stocks from year to year and disequilibria arising from decision errors by producers. The existing literature of the Waugh, Massell, Turnovsky (1976) vein along with the optimal storage work pioneered by Gustafson deals with the effects of disequilibrium over time and the gains attainable by its reduction through storage, while Turnovsky's 1974 article is concerned about the losses due to producers' decision errors particularly errors resulting from faulty expectations.

Instability shifts supply curves because it is more costly to produce at fluctuating levels of output than at a constant output level. These higher average costs arise because fixed inputs must be partly idled during periods of low output. Instability will also shift supply curves if producers are risk averse. When confronted with increased instability a risk averse producer shifts resources toward alternative enterprises with greater safety but lower average returns. The resulting shifts in the supply curve are measurable as losses in producer and consumer surplus.

Several writers including Gustafson and Helmberger and Weaver have mentioned that private storers would not provide socially optimum inter-year carryovers if private risk bearing costs are larger than those of government. Perhaps a stronger rationale for government involvement in stabilization, however, is the potential increase in welfare through a positive supply curve shift. It is not clear that private storers would reduce price variability to the extent that maximizes social welfare when this additional effect is considered. Our analysis examines the possibility that stabilization beyond that attained through private storage can add to net economic surplus.

The Simulation Model

Our overall view of the wheat industry stabilization problem is illustrated in figure 1 which shows how instability and selected stabilization measures relate to social welfare. On the left side of the figure are the major sources of instability; across the top are some of the policy instruments or controlled variables available to policymakers and on the right are selected target variables which include measures of social welfare. The policy problem involves finding levels for the controlled variables that provide the best attainable combination of target variable levels, given the shocks introduced from the left and the economic relationships in the center. Simulation provides a means for exploring the relationships between the controlled variables and the target variables where these relationships are too complex to be worked out analytically.

Within the model are three major kinds of relationships that translate the exogenous shocks and the levels of the policy variables into welfare effects on producers and consumers. First is a producers' price expectation mechanism that may exacerbate fluctuations in supply and demand through distributed lags. Next is a supply response relationship which shifts to the left as the level of instability increases. Finally we have the private and government storage operations which modify the effects of instabilities in output on consumers' and producers' welfare.

For the simulations reported in this paper the support price and the release price were the only policy instruments.[2/] The target variables include domestic consumers' surplus, producers' surplus, foreign consumers' surplus, price, return per acre, and other variables. For each repetition the model generated the time paths of the target variables for a period of 10 years starting in 1979. By combining the results from repetitions, the means and standard deviations of the target variables are projected for each year and each policy alternative.

The simulator contains two blocks of equations representing the major supply and demand relationships in the U.S. wheat industry. Production and total available supply are determined in the supply block prior to the determination of price, domestic utilization, exports, and private and government carryover in the demand block. Acreage, yield, domestic demand, and foreign demand each include random shocks drawn from computer generated normal probability distributions with variances equal to those observed historically.

Supply Block

Production in the model is determined by equations 1, 2, and 3 in Table 1.[3/] For each year in each repetition of the simulator, planted wheat acreage, as shown in equation 1, is calculated as a linear function of farmers' expected price, a lagged moving standard deviation of returns per acre, and a random shock. Under lagged expectations expected price is,

$$P_t^* = \sum_{i=1}^{n} w_i P_{t-1}$$

where n is the length of lag and the w_i are the lag weights which sum to

Figure 1: Relationships among instability sources, stabilization policy variables and welfare

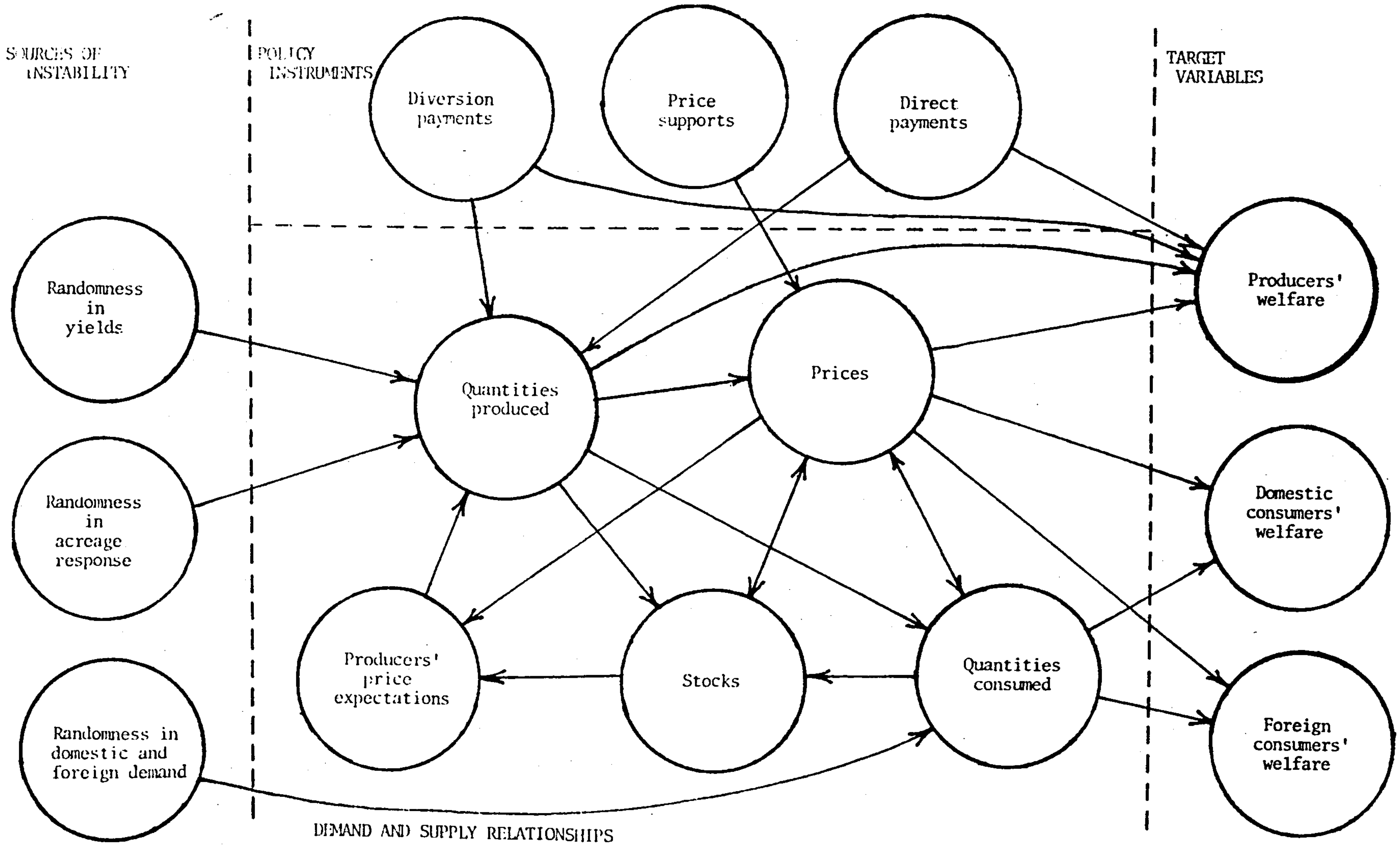


Table 1: Major relationships in the model 1/

Number	Equation	Description
1.	$A_t = a_{0t} + a_1 P^*_t - a_2 V^*_t + e_{1t}$	Acreage response
2.	$Y_t = y_{0t} + e_{2t}$	Yield
3.	$Q_t = A_t Y_t$	Production
4.	$D_t + d_1 P_t = d_{0t} + e_{4t}$	Domestic demand
5.	$F_t + f_1 P_t = f_{0t} + e_{5t}$	Foreign demand
6.	$C_t + \sum_{k=1}^{m} c_{1k} P_t = \sum_{k=1}^{m} c_{0k}$ 2/	Private carryover demand
7a.	$S_t = Q_t + C_{t-1}$	Supply when government stocks are isolated from the market
7b.	$S_t = Q_t + C_{t-1} + G_{t-1}$	Supply when government stocks are released
8.	$G_t = G_{t-1} + Q_t - D_t - F_t - C_t$	Government carryover
9.	$X_t = Y_t P_t$	Gross returns per acre

1/ Variables are represented by capital letters and parameters by lower case letters. (See table 2 for definitions of the variables). A zero subscript indicates a constant term and a one subscript indicates a coefficient measuring quantity change per unit change in price. Coefficient a_2 measures the influence of instability on acreage. Disturbance terms are represented by the e_{jt} where j is the equation number. An asterisk indicates the expected value of a variable. Variables on the right side of the equal signs are predetermined.

2/ The private carryover function consists of the sum of a series of linear functions each representing discounted excess demand for a particular future year. The c_{0k} and c_{1k} are the intercepts and slopes of the discounted excess demand functions and m is the maximum number of years of expected storage. Seldom is m greater than 3 and m is zero when the current price, P_t, plus the cost of storage exceeds the expected price, P^*_{t+1}.

Table 2: Definitions of variables

Variable	Definition
A_t	Acres planted, mil. acres
C_t	Private carryover at end of year t, mil. bu.
D_t	Domestic utilization, mil. bu.
F_t	Exports, mil. bu.
G_t	Government carryover at end of year t, mil. bu.
H_{gt}	Return on government storage operations, mil. $
H_{pt}	Return on private storage operations, mil. $
P_t	Farm price, $/bu.
Q_t	Production, mil. bu.
R_t	Producers' cost of instability, mil. $ 1/
S_t	Supply, mil. bu.
V_t	Standard deviation of returns, $/acre
W_{pt}	Producers' surplus, mil. $
W_{dt}	Domestic consumers' surplus, mil. $
W_{ft}	Foreign consumers' surplus, mil. $
X_t	Producers' gross returns, $/acre
Y_t	Yield per acre planted, bu.
Z_t	Producers' variable costs with complete stability, mil. $

1/ Includes the income that producers would be willing to give up for stability because of using fixed inputs nonoptimally as acreage fluctuates and because of their aversion to risk.

1.0. The capability to form price expectations semi-rationally is also built into the simulator and used for determining private carryover. Under this alternative expected price is,

$$P^{*} = (d_{0t} + f_{0t} - a_{0t}y_{0t} + a_{2}y_{0t}V_{t}^{*})/(a_{1}y_{0t} + d_{1} + f_{1})$$

This formula requires expected standard deviation of return to be known. For the empirical results reported here, a 5 year lagged standard deviation of return was used as an estimate of V_t^*.

Yield is specified as a trend value plus a random disturbance in equation 2. Equation 3 defines production as acreage times yield.

Demand Block

The demand block determines price and allocates total supply among domestic use, exports, private carryover and government carryover. Equations 4 and 5 represent domestic and export demand, respectively, and permit us to calculate the quantities utilized at any specified price. Determination of private demand for carryover is more complex as explained below. Supply is first specified as production plus private stocks and the three demand functions are combined to determine the price at which that supply would be absorbed by the market. If the price so determined lies between the support price and the release price, it is used as the market price. If this price is below the support price, the support price becomes the market price. If this price exceeds the release price, government stocks are added to supply and a new market clearing price is determined. The market price is then set either at this new market clearing price or at the release price, whichever is higher. Once market price is determined quantities absorbed by domestic demand, export demand, and private demand for carryover are calculated and the residual, if any, is assigned to government carryover.

Demand for Private Carryover

Demand for private carryover is specified under the assumption that private storers take the long-run equilibrium price as their expected price for future years and store if and only if this expected price exceeds the current price by enough to cover storage costs including interest on the grain. In one sense, this is a conservative storage rule since storers can expect to sell their stocks in those future years when price is above the long run average price.4/ However, carrying interyear stocks, beyond working stocks, is an extremely risky undertaking, as our results demonstrate, and it seems likely that private storers would require considerable compensation for bearing such risks. Indeed, private storers seem likely to discount future returns by more than the risk free interest rate causing them to carry fewer stocks than our standard storage rule implies. We have therefore begun to examine the effects of raising private storers' discount rate.

In the absence of risk aversion the demand for carryover as represented by equation 6 in Table 1 is the sum of the discounted expected excess demand functions for future years.

$$C_t = \sum_{k=1}^{m} (c_{0k} - c_{1k} P_t)$$

This summation is illustrated in Figures 2a and 2b for m = 3. The price below which storage occurs for expected use K years in the future is,

$$P_k = p^*/(1 + r)^k - \sum_{J=1}^{k} h/(1 + r)^{j-1}$$

where r is the interest rate and h is the annual storage cost excluding interest on the grain. Private storers were assumed to have semi-rational price expectations, P*, as previously described. The slopes of the discounted excess demand curves shown in Figure 2a are derived from the coefficients in the demand and supply curves in Table 1 as follows.

$$c_{1k} = (1 + r)^k (-d_1 - f_1 - a_1 y_{0t}), \qquad k = 1, 2, \ldots m$$

where $(1 + r)^k$ is an adjustment for effect of price change on the interest cost of storage. The intercepts in the excess demand curves are,

$$c_{0k} = -c_{1k} p_k, \qquad k = 1, 2, \ldots m$$

and the quantity coordinates for the kinks in the total demand for carryover function, Figure 2b, are

$$q_1 = 0$$

$$q_k = \sum_{j=1}^{k-1} d_{1k} (p_j - p_k), \qquad k = 2, 3, \ldots m$$

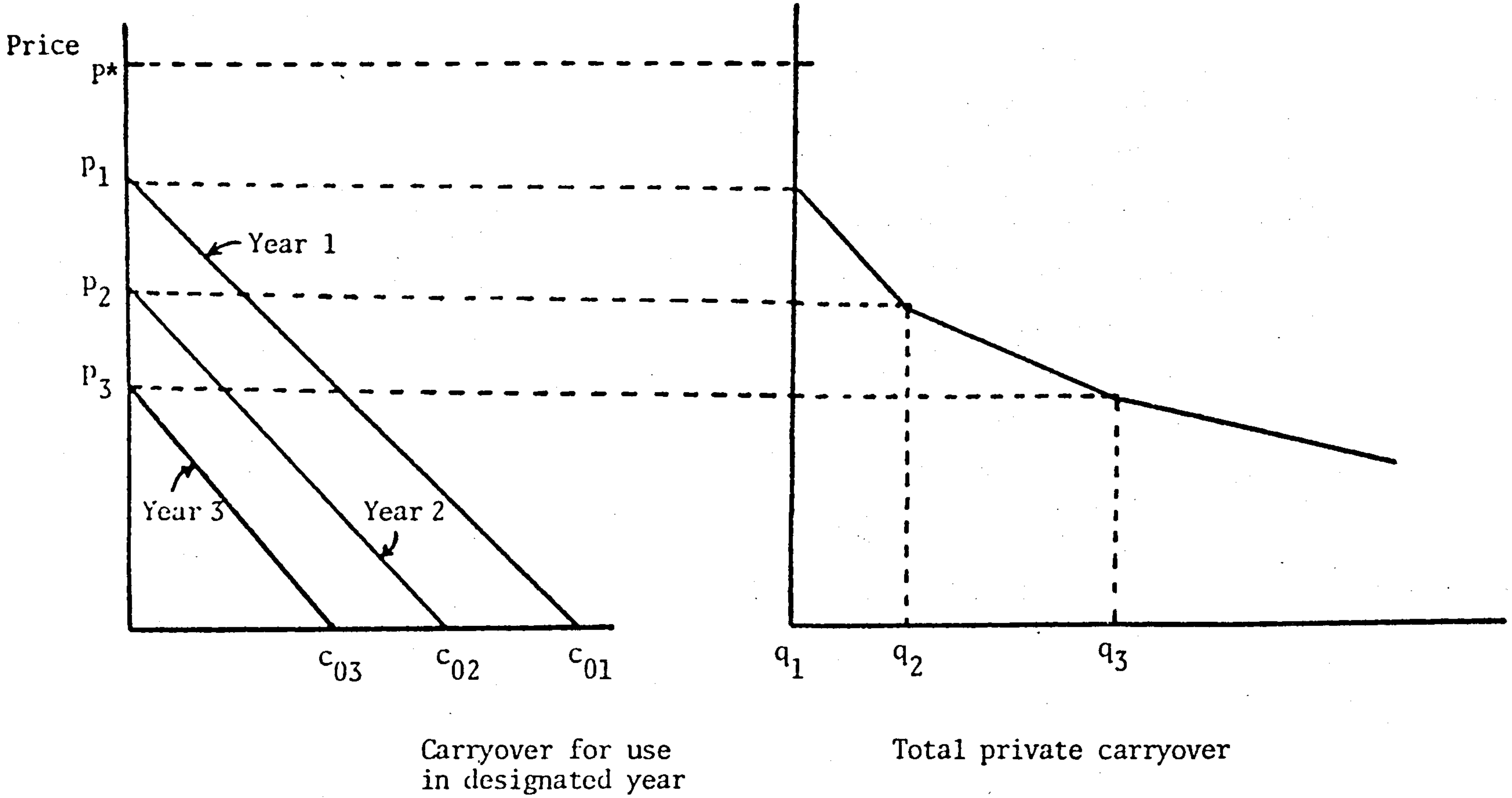
In the computer program the private demand for carryover function is constructed one segment at a time starting with the first segment as shown in Figure 2b and proceeding until a price is found where the total quantity demanded for consumption plus carryover equals supply.

Economic Surplus Estimation

Except for one table providing results for the free market alternative, our economic surplus estimates are reported as differences from the levels projected under a free market policy. Estimates of differences appear to be less sensitive to functional form than are estimates of total economic surplus and it is the differences that are important in evaluating policy alternatives.

Figure 2a: Excess demand functions for future years 1 to 3.

Figure 2b: Total demand for private carryover



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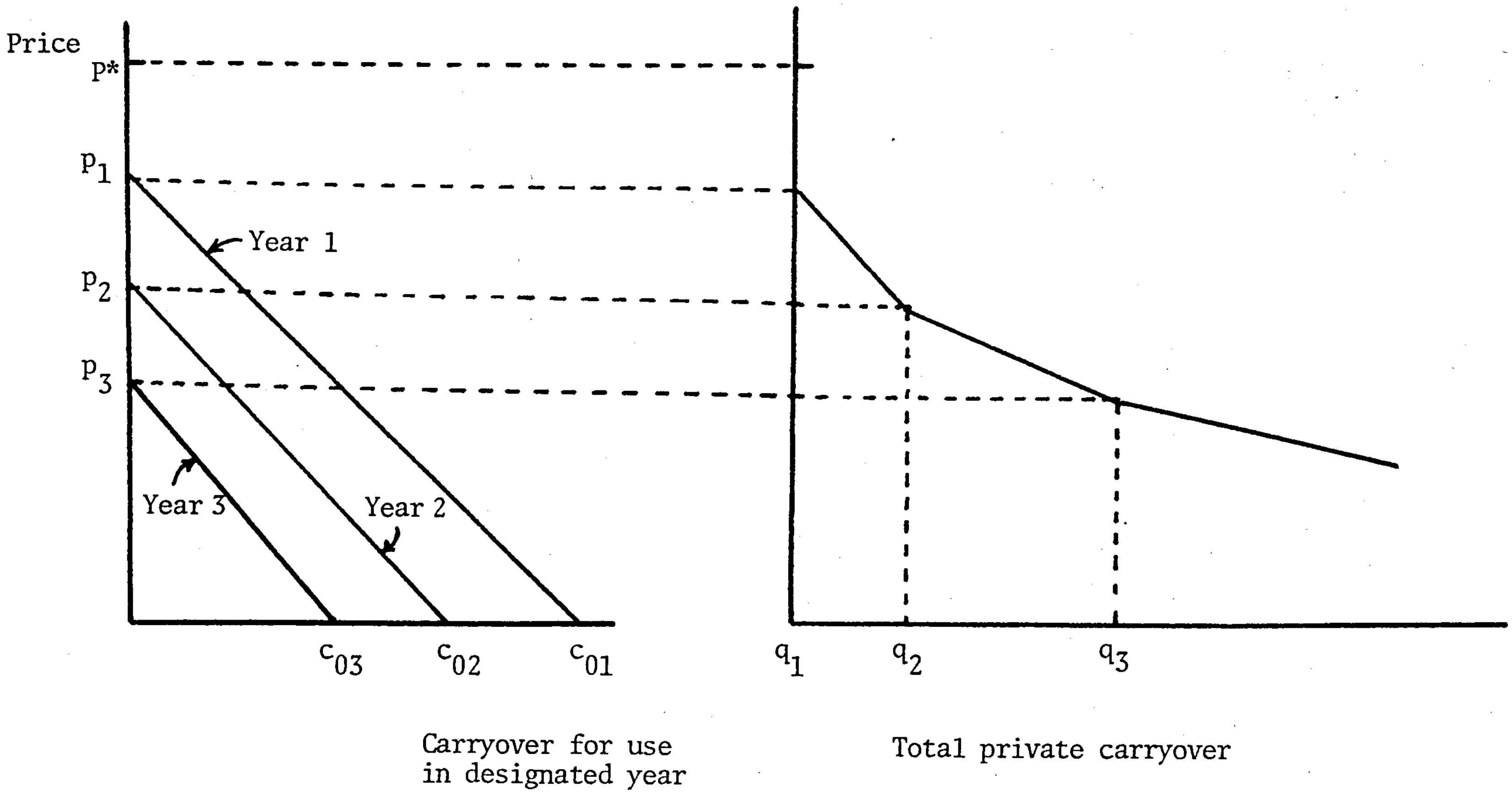

Domestic and foreign consumers' surplus were estimated by the areas above the price line and below the domestic and export demand curves, respectively. 5/ The following two formulas were used in calculating these estimates.

$$W_{dt} = .5\ D_t^2/d_1$$

$$W_{ft} = .5\ F_t^2/f_1$$

Producers' surplus was estimated by subtracting the costs for planned production from gross revenue. 6/ Costs can be divided into two components. Those costs attributable to instability in return are estimated as the area bounded by the supply curve under instability, the supply curve that would exist if instability were absent, and the expected level of production. The formula is as follows:

$$R_t = (y_{0t}/a_1)a_2 A_t V_t^*$$

The remaining variable production costs are measured by the area bounded by risk free supply curve and expected production.

$$Z_t = (y_{0t}/a_1)(0.5A_t^{\ 2} - a_{0t}A_t)$$

giving the following formula for producers' surplus.

$$W_{pt} = Q_t P_t - (y_{0t}/a_1)(-a_{0t}A_t + 0.5A_t^2 + a_2 A_t V_t^*)$$

Private storage return equals the difference between the value of sales and the value of purchases each year minus warehouse costs and interest on the money invested in the grain,

$$H_{pt} = P_t(C_{t-1} - C_t) - (h + rP_t)C_t$$

where h is the annual cost of storage and r is the interest rate. Similarly, government storage returns are calculated as,

$$H_{gt} = P_t(G_{t-1} - G_t) - (h+rP_t)G_t.$$

The surplus measures, private storage return, and government storage returns are added and compared between policy alternatives.

The reported economic surplus differences depend upon how the supply curve is presumed to shift due to differences in the level of instability between policy alternatives. These differences also depend upon the nature of the random shifts in supply and demand. By employing linear functions with additive disturbances we are assuming that shifts in our curves are parallel whether they result from changes in the level of risk or from other factors.

Table 3: Coefficients used in simulation

	Acreage planted mil. acres	Yield bu./acre	Domestic utilization mil. bu.	Exports mil. bu.
Projected 1979 levels 1/	69.5	27.2	789	1140
Projected annual change	0	+.27	+1%	+1%
Price elasticity	0.86	--	-0.25	-0.35
Price coefficient 2/	17.74	--	-58.53	-118.40
Risk elasticity	-0.15	--	--	--
Risk coefficient 3/	-0.35	--	--	--
1979 intercept	20.16	27.2	986	1539
Std. dev. of disturbance	5.00	2.1	24	100

1/ We assume that these are the expected levels with price at $3.37 and standard deviation of returns at $30.00 per acre.
2/ Based upon price at $3.37 and projected 1979 quantities. Acreage planted is a function of prices for years t-1 to t-5 with weights 0.58, 0.29, 0.08, 0.04 and 0.01 respectively derived from Lin's work.
3/ Based upon a standard deviation of return of $30.00 per acre. Expected standard deviation of return is calculated from the returns for years t-1 to t-5.

Table 4: Historical values for selected variables

	Crop year				
	1974	1975	1976	1977	1978
Acreage planted, million 1/	71.0	74.8	80.2	74.8	66.3
Yield, bu./acre 1/	25.1	28.4	26.7	27.1	26.8
Production, mil. bu. 1/	1782	2122	2142	2026	1778
Domestic utilization, mil.bu.1/	672	721	748	840	770
Exports, mil. bu. 1/	1018	1173	950	1124	1150
End-of-year stocks, mil.bu.1/	435	665	1112	1176	1036
Farm Price, $/bu. 1/	4.09	3.56	2.73	2.31	2.90
Returns, $/acre 2/	102.66	101.10	72.92	62.60	77.72

1/ Obtained from Wheat Situation, Nov. 1978.
2/ Calculated by multiplying yield times price.

Results

We present here some preliminary results illustrating use of the model to determine: (1) What is the optimal price band width for a government buffer stock program? (2) How sensitive are conclusions about price band widths to assumptions about producers' response to risk? and (3) How sensitive are such conclusions to assumptions about private storage?

The results reported here are based upon 100 repetitions for each policy alternative over the 10 year period 1979-88. The simulations were performed using an assumed 1979 equilibrium price of $3.37 and moving standard deviation of return per acre of $30.00. Instead of projecting values for the exogenous variables independently over the period of simulation, we projected values of acreage, yield, domestic demand and foreign demand expected to prevail with price at $3.37 per bushel and moving standard deviation of return at $30.00 per acre. The projected first year values and annual changes are shown in Table 3. These projected values were used in combination with estimated slopes to calculate intercepts for each year. Slope coefficients were calculated at the 1979 projected quantities and the assumed equilibrium price and standard deviation of return using elasticities obtained from other studies. The elasticities, slope coefficients and 1979 intercepts are shown in Table 3.

The elasticities of acreage response to price were derived by summing estimates provided by Bill Lin for selected states and converting the aggregate acreage effects to elasticities. Equilibrium acreage was projected to be constant over the period of simulation. Yield trend and variability estimates are based upon work by Larry Deaton. Both domestic demand and exports were projected to increase one percent annually. The price elasticities of demand are based on unpublished work by John Murray. Projected prices, returns and welfare measures are in 1978 dollars. Other coefficients used in the simulations include a real interest rate of 3 percent annually and an annual storage cost of 20¢ per bushel.

Because producers' price and risk expectations are assumed to be functions of lagged prices and returns, five years of historical values were required to start the simulations. These and other related variables for 1974-78 are shown in Table 4.

The simulation results take the form of projected means and standard deviations of the target variables by year over the period of simulation. Example results for 100 repetitions with no government program are presented in Table 5. Because they are very sensitive to assumptions about functional form the estimates of economic surplus shown are of interest not in an absolute sense, but only as they relate to other estimates for the same variable. In subsequent tables the surplus measures, as well as other target variables, are reported as differences from these projected free market levels.

These example results show low prices and low returns to producers in 1979, as existing government stocks are absorbed by consumers and private storers, and then a gradual return toward equilibrium levels with average private stocks of about 150 million bushels in 1984-88. The moderate growth in the surplus measures shown over the decade results from increasing yields and increasing domestic and foreign demand. It is interesting to note that private storers approximately break even in the 1984-88 period, but the standard deviation of their profits is quite large.

Table 5: Projected means and standard deviations of selected target variables under free market assumptions, 1979-88 1/

Target Variable	Years					
	1979	1980	1981	1982	1983	1984-88
Production, mil. bu.	1680	1653	1858	1969	2071	2082
	(117)	(188)	(296)	(311)	(317)	(310)
Private end-of-year stocks, mil. bu.	637	233	114	105	157	151
	(208)	(210)	(173)	(171)	(213)	(211)
Price, $/bu.	2.53	2.92	3.31	3.46	3.23	3.32
	(0.12)	(0.62)	(0.91)	(1.10)	(0.76)	(0.89)
Gross returns, $/acre	69.27	80.09	90.69	95.84	91.23	95.53
	(4.82)	(14.55)	(20.90)	(25.62)	(19.41)	(22.95)
Producers' surplus, mil. $	2291	3157	4236	4348	3816	3908
	(311)	(827)	(1367)	(1799)	(1633)	(1641)
Domestic consumers' surplus, mil. $	6104	5901	5591	5572	5843	6185
	(365)	(591)	(732)	(863)	(678)	(795)
Private storage profit, mil. $	-453	1130	398	74	-133	7
	(569)	(643)	(738)	(735)	(785)	(738)
Total domestic surplus, mil. $	9163	10188	10225	9994	9526	10100
	(735)	(912)	(1294)	(1555)	(1727)	(1543)
Foreign consumers' surplus, mil. $	6546	6393	5854	5882	6061	6438
	(1160)	(992)	(1242)	(1242)	(1122)	(1223)
Total surplus, mil. $	15709	16581	16079	15876	15587	16538

1/ Parentheses contain projected standard deviations.

To compare government program alternatives, four price band widths were considered: ±20%, ±10%, ±5%, and ±1%. Because they reduce producer risk the price band stabilization programs shift the supply curve to the right reducing equilibrium price. To attempt to support price at the $3.37 equilibrium price would result in excessive stock build up. Therefore, the midpoints of the price bands were adjusted by trial and error so that average government stock change over the five years 1984-88 was approximately zero for each alternative.7/

Comparisons between the projected means and standard deviations for selected target variables under the four price band alternatives are presented in Table 6. Averages for 1984-88 are shown because they are more nearly free of the effects of initial stock levels than are the results for earlier years. Results are reported as differences from free market levels as shown in Table 5.

These results illustrate that as the price band is made narrower the standard deviation of gross returns per acre is reduced reaching a minimum at about ±10% price band and then increasing for the ±5% and ±1% price bands.8/ Production increases and average price declines as the variability of returns is reduced. Thus, under inelastic demand, stabilization reduces producers' average gross incomes. But, at the same time, producers gain substantially from reduced costs for bearing risks and dealing with output fluctuations. When these effects are combined producers' surplus is increased by stabilization. Both domestic and foreign consumers also gain. Among the price bands considered, the ±10% price band maximizes both domestic surplus and foreign surplus. Under the ±10% price band storage rule producers' gains during the 1984-88 period amount to about 4 percent of the value of the wheat crop while domestic consumers' gains are about 2 percent of the crop value. 9/

The sensitivity of some of the estimated stabilization effects to the elasticity of acreage response to risk is examined in Table 7. Column 1 in the table shows the effects that a ± 10% price band would have on welfare if acreage were independent of variability of return. The effects on domestic surplus and total surplus are negligible in this case. In contrast, when the elasticity of acreage response is -0.30, as shown in the third column, the indicated effects on welfare are large approaching $1 billion per year in total. This shows that the gains from stabilization depend heavily upon how farmers react to changes in the variability of returns. If farmers were risk netural and if average costs were not affected by variations in output, little would be gained by stabilization.

The sensitivity of results to assumptions about the behavior of private storers is shown in Table 8. In the first column we report the results obtained under standard assumptions where storers discount future returns by the assumed real risk-free interest rate of 3 percent. In the next two columns we assume they discount future returns by 25 and 50 percent respectively. All columns show estimated differences in target variable levels between the ± 10% storage rule and the free market. Comparison of the columns shows that as the discount rate for private storers increases, the amount of private storage declines and the impact of government storage on domestic welfare and total welfare increases. Unfortunately, we do not know at this time the discount rate that private storers use in making their storage decisions.

Table 6: Effects of price band width on means and standard deviations of selected target variables, differences from free market levels under standard assumptions, 1984-88 averages 1/

Target variable	Price band			
	± 20%	± 10%	± 5%	± 1%
	$2.64-3.96	$2.70-3.30	$2.76-3.06	$2.82-2.88
Govt. stock change, mil. bu./yr	8	-8	-9	-8
Production, mil. bu.	23 (-51)	22 (-58)	18 (-53)	11 (-37)
Price, $/bu.	-0.11 (-0.34)	-0.18 (-0.40)	-0.17 (-0.34)	-0.12 (-0.24)
Gross returns, $/acre	-2.90 (-9.09)	-4.93 (-10.47)	-4.48 (-8.62)	-3.18 (-5.88)
Producers' surplus, mil. $	235	287	273	201
Domestic consumers' surplus, mil. $	77	138	127	91
Private storage profit, mil. $	8	-9	-11	-11
Govt. storage profit, mil. $	-143	-25	-5	-3
Total domestic surplus, mil. $	177	391	383	278
Foreign consumers' surplus, mil. $	111	202	187	136
Total surplus, mil. $	288	593	570	414

1/ Parentheses contain differences in standard deviations from free market levels.

Table 7: Sensitivity of estimates to the elasticity of acreage response to risk, differences between ± 10% price band and free market levels, 1984-88 averages 1/

Target variable	Elasticity of acreage response of risk: 0	-0.15	-0.30
Govt. stock change, mil. bu./yr.	-5	-8	-25
Production, mil. bu.	16 (-31)	22 (-58)	32 (-36)
Price, $/bu.	-0.03 (-0.17)	-0.18 (-0.40)	-0.34 (-0.28)
Gross returns, $/acre	-0.56 (-4.56)	-4.93 (-10.47)	-9.65 (-7.38)
Producers' surplus, mil. $	17	287	260
Domestic consumers' surplus, mil. $	12	138	286
Private storage profit, mil. $	-62	-9	-2
Govt. storage profit, mil. $	18	-25	32
Total domestic surplus, mil. $	-15	391	576
Foreign consumers' surplus, mil. $	17	202	418
Total surplus, mil. $	2	593	994

1/ Parentheses contain differences in standard deviations from free market levels.

Table 8: Sensitivity of estimates to the private storage discount rate, differences between ± 10% price band and free market levels, 1984-88 averages 1/

Target variable	Private storage discount rate		
	3%	25%	50%
Govt. stock change, mil. bu./yr.	-8	-10	-10
Production, mil. bu.	22 (-58)	49 (-115)	67 (-179)
Price, $/bu.	-0.18 (-0.40)	-0.34 (-0.65)	-0.46 -1.02
Gross returns, $/acre	-4.93 (-10.47)	-9.27 (-18.20)	-12.66 (-28.82)
Producers' surplus, mil. $	287	534	947
Domestic consumers' surplus, mil. $	138	248	322
Private storage profit, mil. $	-9	-88	-116
Govt. storage profit, mil. $	-25	22	22
Total domestic surplus, mil. $	391	716	1175
Foreign consumers' surplus, mil. $	202	348	434
Total surplus, mil. $	593	1064	1609

1/ Parentheses contain differences in standard deviations from free market levels.

Tentative Conclusions and Plans for Further Work

The preliminary results reported in this paper show that price bounding government stabilization programs for wheat can be expected to reduce farmers' gross incomes but increase their welfare when the costs of instability are taken into account. Such programs also increase domestic and foreign consumers' surplus. The reduction in variability of producers' returns and the consequent shift in the supply curve provides the primary source of gain from stabilization. Without these gains price band stabilization programs would have relatively small effects on social welfare.

We found that the estimated welfare effects of stabilization are quite sensitive to assumptions about producers' risk response and the discount rate for private storers. Further refinement, validation and sensitivity testing of the model are needed before final conclusions can be drawn.

Our results point to several areas where additional information about economic relationships is needed for evaluating stabilization policies. Of particular value is better information about private stockholding behavior and more precise estimates of producers' risk response and export demand.

Our immediate plans call for extending the model in three major ways. First we intend to provide for non-linear demand and supply functions with multiplicative disturbances to test the sensitivity of results to assumptions about functional form. Second, we plan to incorporate government storage rules that vary with the supply or price and more closely approximate the Gustafson type of optimal storage rule. Third, we want to introduce other policy variables such as direct payments, acreage diversion payments, storage subsidies, and returns per acre guarantees.

Footnotes

1. Welfare generated in the marketing sector is included with consumers' welfare in this study.

2. In future simulations we plan to introduce other policy instruments including target prices, direct payments, diversion payments and storage subsidies.

3. Definitions of variables are shown in Table 2.

4. The optimum carryover for profit maximizing storers can be determined by dynamic programming. We are indebted to Pauline Ippolito for helping to clarify the advantages of the dynamic programming approach. We have not attempted to introduce a dynamic programming solution in our model.

5. In calculating consumers' surplus we must specify whether the observed fluctuations in quantities demanded are deviations from the true demand curve or shifts in the curve itself. The results reported here are based upon the latter assumption; the quantity consumed always lies on the demand curve. This differs from our previous work (Plato, Heifner, and Murray) where we assumed that domestic consumption deviated from the demand curve.

6. Producers' surplus cannot be measured by the area above the supply curve and below the price line when expected and actual production differ as is generally the case in our model.

7. This procedure does not necessarily lead to an optimal level of government stocks. Ideally, the price band should be changed over time to adjust expected carryover to optimal levels. This is beyond the analysis reported here.

8. This illustrates a point made by Coleman that price stabilization beyond a certain point can destabilize producers' returns because of yield variability.

9. These estimates of the welfare gains to producers from stabilization are relatively larger than our previous analysis suggested (Plato, Heifner, and Murray). The previous analysis did not take into account the gain in expected revenue from stabilization that occurs through reducing the covariance of price and production.

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