Wheat Buffer Stock Policy Alternatives

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Abstract

Grain Stocks largely have been unplanned byproducts of commodity price support programs. This paper estimates the economic impact of alternative wheat buffer stock policies. The economic implications of seven stock policy alternatives were examined herein ranging from a free market to solely government storage managed by various rules.

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Introduction

During most years of the six decades since major commodity programs originated, grain stocks largely have been unplanned byproducts of price support programs. Stocks have been excessive by many standards, depressing farm prices and incomes while costing taxpayers billions in storage costs. For the most part, consumers at home and abroad have been assured of ample food supplies but at a considerable cost in government outlays from taxpayers and low farm prices to producers. Given federal budget stringency, at issue is whether commodity program and stabilization goals can be met at less cost to taxpayers and society.

The main purpose of this paper is to estimate the economic impact of wheat buffer stock policies. The task of designing and implementing the policy raises several questions:

1. Will reserves provided by the market alone be "adequate" if government commodity programs are scaled back under budget stringency? A related issue is how to define the term "adequate."
2. To what extent do various public buffer stock policies meet the needs of producers, consumers, taxpayers, and the nation as a whole? Interests of these groups often conflict, and it is necessary to devise a stock policy that recognizes tradeoffs. The *social cost* criterion applied in this study attempts to accommodate tradeoffs in a single performance measure. Other payoff measures also are included.

Conceptual Framework and Model

A buffer stock policy adds value to society by accumulating stocks when value (price) is low for resale when value is high. An appropriate instrument or trigger mechanism needs to control stocks to achieve desired outcomes. The most obvious instrument is the market. If that is inadequate, the public could supplement the market with subsidies to private stockholders. Or a government agency could assume major responsibility for stock management, adjusting stocks based on prices, production, supply, or other variables.

Another critical issue is the appropriate value or variable to optimize. It is possible to operate a stock policy to maximize farm income or prices, to minimize consumer and taxpayer cost, or to minimize variability. An attractive criterion is net social loss, defined as the overall net value of goods and services foregone from instability. Minimizing net social cost maximizes the contribution of a stock policy to the real value of goods and services in society.

Conceptual Framework

Figure 1 illustrates how buffer stock policies work to raise the real value of wheat consumption. In panel A, demand is fixed at D. Short-run supply (production) is assumed to vary between Q randomly occurring half the time and Q´ randomly occurring half the time. In the very short run, production cannot be varied by adding more inputs in response to price so supply quantity Q is at the vertical lower supply curve S_L and Q´ is at the vertical upper supply curve S_U.

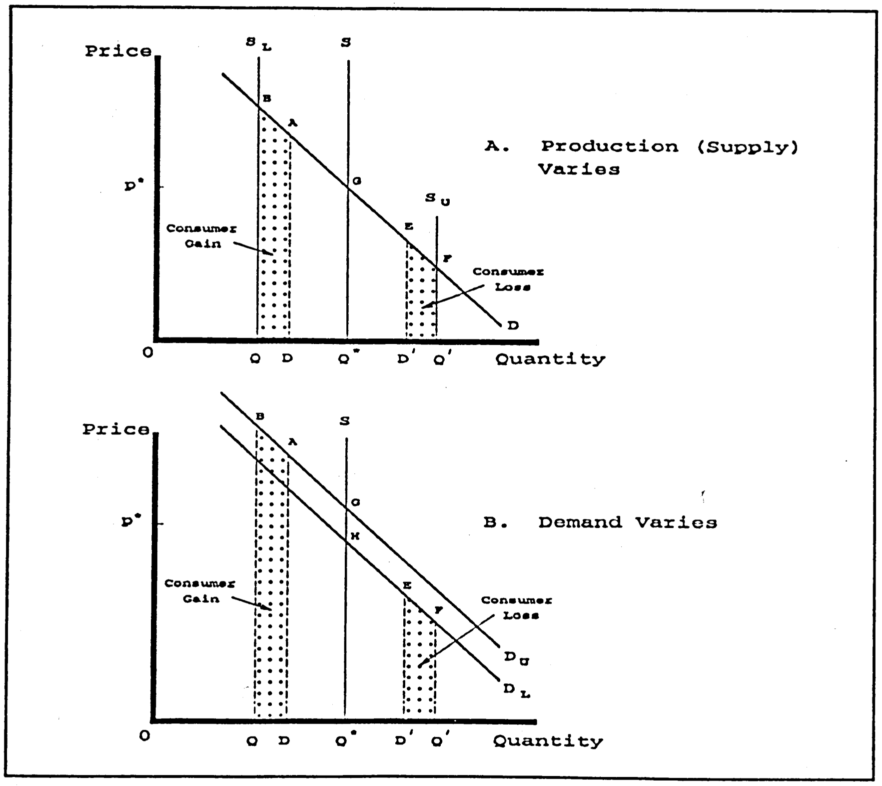

Figure 1. Consumer Surplus Gains and Losses with Buffer Stocks when Supply Varies (A) and when Demand Varies (B).

A buffer stock policy removes Q´D´ from the market when supply is high (S_U) and prices are low and releases QD on the market when prices are high and supply is low (S_L). The loss to consumers of area D´EFQ´ when supply is large is less than the gain to consumers of area QBAD when supply is low. The result is a net social gain from buffer stocks equal to the difference between the shaded areas in panel A of Figure 1 and less the cost of storage. If storage costs were zero, supply could vary from Q to Q´ but consumption could be Q^* each year. A buffer stock policy could seek to maximize the *net* shaded areas in panel A or minimize the area DAED´ -- in each case counting storage cost.

Panel B of Figure 1 shows gains from a buffer stock policy when demand varies from a lower level D_L to a higher level D_U, each with equal probability. Supply is vertical and fixed at S in the short run considered in the analysis.

A buffer stock policy removing D´Q´ from the market when price and demand are low reduces the value of consumption by area D´EFQ´. When price and demand are high, quantity QD is released from stocks to the market at a gain to consumers of area QBAD. The net gain is the shaded area labeled "consumer gain" less the shaded area "consumer loss" in panel B of Figure 1.[1] The net benefit to society is this net area less storage cost. As storage costs approach zero, consumption is more fully stabilized.

Social loss also can be approximated by the area of deviation from the equilibrium price and quantity. With the stock policy, consumers gain by area GED´Q^* when quantity available for consumption is large and the wheat price is lower than the equilibrium price, P^* (see panel A in Figure 1). However, when quantity available for consumption is low and the price is higher than P^*, then consumers have a loss of area AGD´Q^*. Net social loss is the net consumer loss plus storage cost. The shaded areas are labeled *social loss 1* and the areas between the shaded areas are labeled *social loss 2* in the later table showing results. Each includes storage costs set at 20 percent of the value of wheat stocks. The equations in the model are specified below.

Model

The wheat stock model is specified as a series of supply and demand equations with price playing the equilibrating role. Demand components include domestic demand, stocks or carryover, and export demand. Supply is the sum of carryover from last period and the current production.

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[1] The shaded areas are the net gains from stock policies measured in value of goods and services to society. The portion actually accruing to consumers and producers depends on prices, quantities, and government payments.

Wheat Demand: The price elasticities of domestic demand and stock are adopted from Dunmore and Longmire (1984, p. 53). The price elasticity of export demand is derived from the domestic demand and stock price elasticities. Elasticities are for the short run of one year. The equations calculated from previously estimated price elasticities but linearized in original values and with intercepts chosen to precisely predict 1980-85 mean values are:

(1) Wheat domestic demand: $QD_t = 29205 - 1025.4P_t$

(2) Wheat stock demand: $QH_t = 94709 - 9236.1P_t - 0.84QX_t$

(3) Wheat export demand: $QX_t = 170170 - 8918.5P_t - 0.23QPW_t + \varepsilon_t$

where QD is the annual quantity consumed by the domestic sectors, QH is the quantity of carryover, QX is the quantity exported, and QPW is the quantity of world production. All quantities are in 1,000 tons. P is wheat price in dollars per bushel. ε in (3) is the stochastic element of the export demand equation randomly chosen from the allowable set of numbers for each iteration. The value of ε is assumed to follow a normal distribution with a standard deviation of 6,427.6 in the export demand equation.

Sector demand equations (1), (2) and (3) give the following aggregate demand quantity

(4) $QT_t = QD_t + QH_t + QX_t$.

Wheat Supply: The quantity of wheat available each period is the sum of production in the current period and carryover from the previous period. Production is a function of last period price and set aside acreage which reflects the impact of domestic policy on production quantity. The estimated equation of production is:

(5) $QP_t = 50423 + 8645.6\, P_{t-1} - 318.6\, AA_t + \nu$

where QP is the quantity of production in 1,000 tons and AA is the set aside land in million acres. ν in (5) is the stochastic element of the production equation assumed to follow a normal distribution with standard derivation of 5,168.7. Standard deviations for exports and production were estimated from historic data.

When the market is in equilibrium, total supply quantity, QS_t, equals total demand quantity, QT_t, at an equilibrium price, P_t.

Miscellaneous Calculations

The storage cost for interest, depreciation, shrinkage, spoilage, repairs, and insurance is assumed to be constant at 20 percent of the stock value.[2] Because supplies are fixed in the short run so production costs cannot vary to change output, producer surplus is not considered in storage policy.

If we only consider *domestic* consumer loss (gain), the domestic demand curve will be used in the Figure 1. Then the sum of domestic consumer loss (gain) and storage cost is defined as *domestic social loss* in our model. The assumption is that foreign consumers are not part of the social welfare function determining optimal shocks. In an alternative scenario, the aggregate domestic and export demand curve is used to calculate total social loss. This assumes that foreign consumer loss (gain) is included in the total social loss calculation for determining buffer stocks. At issue is whether to design the buffer stock policy to serve national or international interests.[3]

The domestic social loss is equation (6)

$$(6) \qquad \begin{aligned} SLD &= R_t - \int_Q^D PD(q)dq, \text{ when releasing stock, and} \\ SLD &= R_t + \int_D^Q PD(q)dq, \text{ when accumulating stock} \end{aligned}$$

where PD_t is the inverse function of domestic demand, QD_t, given as equation (1), and R_t, storage cost, is,

$$(7) \qquad R_t = 0.2 * \text{Average}(QH_t + QH_{t-1}).$$

The total social loss, SLT, is calculated precisely as in equation (6) except that PDT_t is the inverse function of the aggregate domestic and foreign demand curve.

Gross farm cash income is calculated as the product of price and quantity marketed each period, while net cash income is gross cash income minus production cost. Only variable production costs are included and land, labor, or overhead expenses are excluded.

The mathematical simulation model used to analyze wheat buffer stock policy was calibrated with parameters as defined above and 1980-85 data. Each scenario was simulated with 3,000 iterations. Each annual

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[2] Cost and other parameters were varied in sensitivity analysis not included in this paper.

[3] In reality, including foreign demand in social welfare makes sense because it reflects increased buying power for *Americans*. U.S. consumers benefit from foreign goods and services purchased with foreign exchange earned from wheat sales.

iteration received its own unique random shocks to production and to exports. Exogenous variables were set at 1980-85 levels. Values are in 1977 prices.

Scenarios

Buffer stock policies or scenarios used herein are defined as below. The conceptual basis for these models come from a number of analysts whose models are discussed elsewhere (Tweeten, Ch. 5).

Base Market: Free market. Buffer stocks are determined by private trade decisions alone. It provides a benchmark against which to compare various public policies defined below to manage buffer stocks. Stock levels for the *base market* and other scenarios are buffer reserves only. *Total* optimal or equilibrium ending stocks would need to add pipeline wheat stocks to the buffer stocks. The free market buffer stock equation in the *base market* scenario is replaced by various stock management instrument models in the public sector intervention policy scenarios described below.

Stock Subsidy: This wheat carryover policy uses a stock subsidy to increase wheat reserves above the base market level. The flat (fixed) rate is a 50 cent per bushel subsidy per year to storers of wheat buffer reserves. The *stock subsidy* policy is programmed to operate as follows:

(8) $$QH_t = 94709 - 9236.1\ (P_t - 50\ ¢) - 0.84\ QX_t.$$

Storers initially receive the subsidy paid by taxpayers.[4] For our purposes, storers are assumed to be producers.

The stock subsidy policy has many similarities to the Farmer Owned Reserve which accepts wheat from the nonrecourse loan programs, leaves ownership title with farmers, subsidizes interest and other storage costs, and terminates subsidies if wheat prices reach prescribed levels. The program herein is simpler.

Production Instrument: The *production instrument* stock control model is designed to achieve optimal inventory control by storing some portion of production when production is large and price is low for release

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[4]The ultimate incidence of benefits from the *stock subsidy* depends on supply and demand elasticities.

when production is low and price is high. The model is especially suited for markets in which shocks arise solely from weather affecting domestic production. It is programmed to operate as follows:

(9)

$$
\begin{aligned}
QH_t &= QH_{t-1} + \beta_1 (QP_t - QP^*), && \text{if } QP_t > QP^* \quad (QP^* = 69468) \\
&= QH_{t-1} - \beta_2 (QP^* - QP_t), && \text{if } QP_t < QP^* \\
&= 0, && \text{if } QH_{t-1} < \beta_2 (QP^* - QP_t)
\end{aligned}
$$

where β_1 is the percentage of excess production quantity ($QP_t - QP^*$) which is to be carried over into the next period and β_2 is the percentage of production shortfall ($QP^* - QP_t$) which is to be released into the current period. When stock runs out, $QH_t = 0$. β_1 and β_2 need not be the same, but unequal values in a given variant can lead to excessive stock accumulation or shortfalls. The model was run using several values for β_1 and β_2, ranging from 0.1 to 1.0. The optimal βs may be chosen to minimize social loss, price variability, or other criterion of interest. In this and all other scenarios in this paper, the superior variant(s) within a policy was selected to represent that policy. Scenarios or variants giving significant incidence of zero stocks were eliminated.

Total Supply Instrument: The *total supply instrument* and *production instrument* policies are similar. The model is programmed to operate as follows:

(10)

$$QS_t = QP_t + QH_{t-1}$$

(11)

$$
\begin{aligned}
QH_t &= QH_{t-1} + \gamma_1 (QS_t - QS^*), && \text{if } QS_t > QS^* \quad (QS^* = 104707) \\
&= QH_{t-1} - \gamma_2 (QS^* - QS_t), && \text{if } QS_t < QS^* \\
&= 0, && \text{if } QH_{t-1} < \gamma_2 (QS^* - QS_t)
\end{aligned}
$$

where γ_1 is the proportion of excess total supply ($QS_t - QS^*$) which is to be carried over into the next period, and γ_2 is the proportion shortage total supply ($QS^* - QS_t$) which is to be released into the current period. If stock runs out, $QH_t = 0$. The γs in any given variant need not be equal. This model was run using several values for γs ranging from 0.01 to 1.0. Because QS_t is greater than QP_t, γ in the *supply instrument* model is expected to be smaller than β used in the *production instrument* model. The optimal γs can be chosen based on minimizing social loss and price variance or based on some other performance criterion.

Price Instrument: Under this policy, stock acquisition and release is a multiple of the difference between actual and equilibrium price. The *price instrument* model is programmed as follows:

(12)

$$
\begin{aligned}
QH_t &= QH_{t-1} + K_1 (P^* - P_t), && \text{if } P^* > P_t \quad (P^* = 2.50) \\
&= QH_{t-1} - K_2 (P_t - P^*), && \text{if } P^* < P_t \\
&= 0, && \text{if } QH_{t-1} < K_2 (P_t - P^*)
\end{aligned}
$$

where K_1 and K_2 are the quantities per anticipated price disequilibrium, $(P^* - P_t)$, in dollars per bushel. The Ks indicate quantities to be carried over into the next period or released into the current period. $QH_t = 0$ when stock is exhausted. As with previous control coefficients, Ks are not required to be equal in any given variant of the model. The model was run using values of K ranging from 1 million to 30 million tons. An advantage of the *price instrument* rule is that it can work to minimize net social cost of instability with a buffer stock policy independent of the source of instability. (In contrast, the production and total supply instruments assume instability comes from supply rather than from demand.) A major disadvantage of the price rule is that it requires anticipation of disequilibrium.

Simulation Results and Conclusions

The results from the above scenarios are shown in Table 1. Means, standard deviations, and coefficients of variation are presented for key variables.

Net Social Cost

Two measures of social costs are estimated in the paper. The first measure, *net social loss 1*, is the consumer gain less the consumer loss shaded areas in Figure 1 adjusted for storage cost. The second measure, *social loss 2*, is the net area between shaded areas plus storage cost (see Figure 1). Social loss 1 is a more exact index of the social worth of stabilization policies but is not available for some scenarios.

No attempt is made here to designate any one stock policy as optimal. Each has advantages and disadvantages.

Scenarios

The *base market* policy minimizes government in agriculture, poses low administrative and tax cost burden, and is surprisingly competitive with other policies in contributing to economic stability. Unfortunately, the private stock demand curve cannot be estimated with high reliability. Hence conclusions must be interpreted with caution.

The *stock subsidy* policy is also market oriented and has the advantage of the *base market* policy plus higher farm income. The higher farm income is a transfer from taxpayers to producers. The *stock subsidy* policy raises farm income and reduces social loss compared to the *base market* policy. It offers attractive tradeoffs between farm income level and price stabilization at low social loss.

The *production instrument* policy (along with the *total supply instrument*) generally gives the lowest social cost. However, public administrative costs and difficult administrative judgments are not accounted for in our estimates. For example, over- or underestimating equilibrium production by a public stock manager can lead to excessive or depleted stocks. Production, as expected, actually varies more with than without this policy. But variable production can disadvantage farmers while it benefits consumers.

The *total supply instrument* policy makes sense by adjusting stocks according to total supply (carryin stocks plus production) rather than only to production. The policy by design results in relatively low stocks to hold down storage costs. It also gives low social cost in foregone national income from instability. Like the related *production instrument* policy, the *total supply instrument* policy tends to break down when random, unpredictable variation is coming from exports rather than from domestic production.

The *price instrument* policy is attractive because it is designed to manage stocks for low social cost whether random variation is coming from supply or demand. It gives lowest variation in wheat prices, gross income, and net income. The policy, or related policies such as keeping price within a prescribed band, is troubled by problems of anticipating deviations from equilibrium price and then adjusting stocks accordingly.

In theory, the price instrument is a preferred criterion (see Tweeten, pp. 145-151) but did not perform especially well in practice. Two sources of wheat market shocks are considered: production and exports. The results indicate, among scenarios, that production and exports are about equally variable as measured by the standard deviation (except for the *production instrument*). However, production is much greater than exports in all cases. Thus the *production instrument* policy, which works best when shocks come mainly from production, is especially effective in reducing export variability.

All of the publicly managed production, supply, or price instrument scenarios give lower social costs than the *base market* and *stock subsidy*. However, the latter two scenarios have other advantages such as ease of administration. Markets would be operated with minimal government intervention and low administrative cost in these instances.

Level of Wheat Prices and Farm Income

Higher stocks mean lower wheat prices on average. Because higher stocks mean higher storage cost, higher stocks might be expected to go with higher social loss. But that is not the case: Higher wheat prices go with higher social costs. The reason is that efficient stock policies going furthest to reduce market instability per unit of social cost also tend to give lower wheat prices. Lower wheat prices satisfy consumers but not producers.

Average gross and net wheat incomes reveal a pattern similar to average wheat prices. High incomes tend to be associated with the least efficient wheat stock policies as measured by social cost. However, the *stock subsidy* option especially raises producers' income from the 50 cent per bushel stock subsidy while reducing social loss from the *base market* level. Of course, net income for the *stock subsidy* would be less if farm storage costs were considered. Because the *stock subsidy* payment gain to producers is a loss to taxpayers, the subsidy does not help to lower the social cost (national income foregone) from that policy. Also, the subsidy is considered here to go to producers but that presumption would not necessarily hold in reality.

Finally, "optimal" buffer stock carryover is indicated by the mean stock variable in Table 1. The optimum ranges from a low of 20 million metric tons for the *total supply instrument* policy to 31 million metric tons for the *supply subsidy* policy. Because the level and variability of social cost, farm income, prices, and quantities are not unequivocally superior for any particular stock policy, the "optimal" stock policy will depend on objectives of the stock program.

Table 1. Simulation Results: Descriptive Statistics of Variables.

Variable	Buffer Stock Policy						
	Base Market	Stock Subsidy $0.50	Production Instrument (0.7, 0.7)	Total Supply Instrument (0.2, 0.1)	Total Supply Instrument (0.1, 0.1)	Price Instrument (3000, 3000)	Price Instrument (10000, 10000)
Production (1000 MT)							
Mean	69468	69745	67349	66709	66649	67477	67881
Standard Deviation	8805	9448	10196	12017	12124	9885	8108
Coef. of Variation	13	14	15	18	18	15	12
Demand (1000 MT)							
Mean	26640	26589	26896	26843	26842	26733	26722
Standard Deviation	767	845	830	1231	1249	891	502
Coef. of Variation	3	3	3	5	5	3	2
Export (1000 MT)							
Mean	39669	39228	41893	41432	41426	40476	40378
Standard Deviation	9172	9423	3289	9852	9980	7976	6888
Coef. of Variation	23	24	8	24	24	20	17
Stocks (1000 MT)							
Mean	26397	30927	27065	20432	20251	25161	26213
Standard Deviation	7666	7743	9669	3344	3354	2666	6280
Coef. of Variation	29	25	36	16	17	11	24
Price (Dollars/Bushel)							
Mean	2.50	2.55	2.25	2.30	2.30	2.41	2.42
Standard Deviation	0.75	0.82	0.81	1.20	1.22	0.90	0.49
Coef. of Variation	30	32	36	52	53	37	20
Gross Income ($ Million)							
Mean	5963	6792	5693	5444	5431	5825	5980
Standard Deviation	1634	1626	2076	2533	2563	1924	1389
Coef. of Variation	27	24	36	47	47	33	23

Table 1 continued.

Variable	Buffer Stock Policy						
	Base Market	Stock Subsidy $0.50	Production Instrument (0.7, 0.7)	Total Supply Instrument (0.2, 0.1)	Total Supply Instrument (0.1, 0.1)	Price Instrument (3000, 3000)	Price Instrument (10000, 10000)
Net Income ($ Million)							
Mean	2931	3745	2654	2372	2387	2768	2914
Standard Deviation	1666	1693	2260	2590	2611	1921	1418
Coef. of Variation	57	45	85	109	109	69	49
Domestic Social Loss 1 ($ Million)							
Mean (excludes export	NA	NA	438	341	338	434	454
Standard Deviation	NA	NA	236	183	180	143	103
Coef. of Variation	NA	NA	54	54	53	33	23
Domestic Social Loss 2 ($ Million)							
Mean	490	514	428	354	349	428	436
Standard Deviation	142	208	262	291	292	235	152
Coef. of Variation	29	40	61	82	84	55	35
Total Social Loss 1 ($ Million)							
Mean	NA	NA	244	181	175	369	407
Standard Deviation	NA	NA	786	185	185	159	377
Coef. of Variation	NA	NA	322	102	106	43	93
Total Social Loss 2 ($ Million)							
Mean	775	625	222	361	347	398	355
Standard Deviation	898	1055	293	1181	1178	894	659
Coef. of Variation	116	169	132	327	339	225	186

Social Loss 1: Includes social gain less social loss (shaded areas in Annex Figure 1) less storage cost. Not available for first two policies in table.
Social Loss 2: Includes areas of social loss between shaded areas in Annex Figure 1 plus storage cost.

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