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Report To The Congress

THE U.S. GENERAL ACCOUNTING OFFICE

Farmer-Owned Grain Reserve Program Needs Modification To Improve Effectiveness: Consequences Of USDA's Farmer-Owned Reserve Program For Grain Stocks And Prices

By Dr. Bruce Gardner

Volume 2 Of Three Volumes

Dr. Gardner's analysis of the farmer-owned grain reserve program shows that there was little effect on inventory levels and price variability.

The amount of grain added to inventories was less than the amount of grain entering the program. This is because reserve stocks in large part replaced private stockholding.

Dr. Gardner estimates that the program's effect on promoting long-term price stability may be significant but is costly, and that the effect on short-term price stability has been minimal.

PREFACE

GAO and two agricultural economists have reviewed the farmer-owned grain reserve program. This volume, written by Dr. Bruce Gardner, examines data on stocks and prices of corn and wheat during the program's first 3 years and estimates its effects.

In addition to this volume, our report includes two other volumes which address the following:

Volume	Description
1	Farmer-Owned Grain Reserve Program Needs Modification To Improve Effectiveness--includes an introductory section on the reserve program; synopsizes information in the two other volumes; describes reserve grain quality problems; discusses storage payments; and contains our conclusions and recommendations.
3	Theoretical and Empirical Considerations in Agricultural Buffer Stock Policy Under the Food and Agriculture Act of 1977--analyzes the major theoretical developments of stabilization policy and then uses this information to develop a model to investigate the effects of the farmer-owned reserve program on prices, quantities, and real income for grain and livestock markets.

CONSEQUENCES OF USDA'S

FARMER-OWNED RESERVE PROGRAM

FOR GRAIN STOCKS AND PRICES

By Dr. Bruce Gardner

SUMMARY

The Farmer-Owned Reserve (FOR) program subsidizes
farmers to hold stocks of grain in reserve in order to
regulate the amount of grain available and thereby stabilize
prices. This report examines data on stocks and prices of
wheat and corn during the FOR program's first 3 years (April
1977-May 1980) and estimates its effects. The analysis
focuses on (1) quantities of stocks, using annual and
quarterly data for wheat and corn, (2) grain prices, using
annual, quarterly, and daily data, and (3) grain price
stabilization, comparing the variability of prices before
and after the FOR program was in effect.

FOR's EFFECT ON CARRYOVER STOCKS

Analysis of annual and quarterly data indicates that
the FOR program had a much smaller effect on the overall
stock of grain than quantities in the FOR suggest at first
glance. The reason is that as participation in the FOR
program increases, stocks held outside the program decrease.
Neither the annual nor the quarterly data permit precise
estimates of FOR effects, but it seems clear that the effects
are weak. The most optimistic estimate that is plausibly
consistent with the data is that 4 bushels of either wheat or
corn in the program are required to generate 1 bushel of
added carryover stocks. At its maximum, the FOR held about
1.2 billion bushels of grain stocks, which means that
300 million bushels could have been added to total grain
stocks. This quantity of grain can be helpful in providing
insurance against future production shortfalls, but it is
expensive insurance. Considering that annual storage costs
are about 25 cents per bushel and interest subsidies may
equal about the same amount, the Government is paying about
$2.00 per bushel per year, excluding administrative costs,
for the added grain stocks.

FOR's EFFECT ON GRAIN PRICES

Regression estimates of the FOR program's effect on
grain prices for the 1977 and 1978 marketing years reveal no
significant direct effects. Nonetheless, the net increase
in stocks could have caused a roughly 4-percent increase in
corn and wheat prices in these 2 years--equaling roughly
$1 billion per year. Because FOR-induced increases in prices
are paid by grain users, the Nation as a whole does not bene-
fit. There is redistribution from consumers to producers and,
to the extent that deficiency payments are reduced, from con-
sumers to the U.S. Treasury. The transfers that occur in

years of FOR accumulation will be roughly offset by transfers favoring consumers at the expense of producers in high-price years when FOR stocks are consumed.

FOR's EFFECT ON PRICE STABILIZATION

The FOR program should stabilize prices in two ways: (1) year-to-year price variation should be less over the long term because the program increases average carryover stocks and (2) prices within individual marketing years should not fluctuate as much because FOR stocks can be manipulated to supply or withdraw grain from the market-place.

Potential long-term stabilization benefits cannot be observed because we have not yet experienced periods of extreme shortage in which FOR stocks would have greatest value. The potential benefits to consumers and producers jointly are estimated to be roughly $75 million annually from simulation of an FOR of the size that existed in 1978. The corresponding governmental subsidy costs are about $300 million. Social resource costs are lower because some of the $300 million is transferred to farmers, paying them to store grain they would have stored anyway. Long-term resource costs are estimated to be of the same order of magnitude as the gains from stabilization. However, these gains exclude unmeasured external social benefits outside the grain markets, such as avoidance of macroeconomic dis-ruptions from severe production shortfalls. To the extent that the FOR increases average stocks, it will be beneficial in achieving these external benefits, although the FOR could be better structured for the purpose.

The primary FOR activities observed to date appear to have been directed at short-term stabilization, but the evi-dence indicates that this effort has not been successful. Corn and wheat prices have been just as variable under the FOR as before its implementation, and analysis of short-term price movements under the FOR uncovers no strong stabilizing influence of program activity. Indeed, thus far the program may actually have destabilized prices.

POLICY ALTERNATIVES

Because of the FOR program's short history, the com-plexities of grain markets, and the lack of some important data, estimates of the program's effects are uncertain. Nevertheless, the overall evidence indicates problems suf-ficient to warrant serious consideration of modifications and alternatives to the FOR program by the Congress and the Department of Agriculture. The most promising modifications

involve steps to (1) decrease the extent to which accumula-
tion of FOR stocks reduces non-FOR stocks, (2) increase the
assurance that some stocks will be held until the extreme
shortage situations occur when stocks are socially most
valuable, and (3) re-orient FCR management away from efforts
at short-term stabilization, frequent policy moves, and
program changes.

Contents

SECTION 1

INTRODUCTION

The Farmer-Owned Reserve (FOR) program has many complex features, as described in the main body of this report, but the essential economics of it are relatively simple. It is a scheme to establish federally managed, subsidized holding of grain stocks by farmers. The subsidy consists of payments to farmers who agree to hold grain in storage for a period of 3 years, plus a loan at a relatively low interest rate. The amount of the loan is the support price, or "loan" price times the quantity placed in the FOR. It is the attempts at Federal management of these FOR stocks that introduce complexities. The Government reserves the right to stop subsidy payments and recall the loans before the 3-year period is over if market prices rise. Storage payments are to be stopped at a "release" price and the loans are to be "called" at a higher "call" price. The loan price, release price, and call prices differ between crops and have been adjusted several times in the 3-year history of the FOR program. In addition, the storage payments and loan terms have been changed a few times.

This report examines the success of the FOR program in achieving its objectives. The objectives, while never precisely defined, are expressed in general terms in the Food and Agriculture Act of 1977 and statements by Department of Agriculture (USDA) officials. The basic objectives are to (1) stabilize farm commodity prices by encouraging farmers to hold commodity stocks in reserve when supplies are abundant and sell stocks from reserves when supplies are scarce and (2) aid in supporting farm returns during low-price periods. The second objective is implicit in the first but is singled out in discussions of Government officials. The special emphasis on farmers' returns is apparent in the use of set-asides (holding land out of production) as a second line of defense against low farm prices. A test of the program's effectiveness therefore involves estimating its effects on stockholding and on the level and variability of market prices.

It should be noted that these effects are immediate objectives but not ultimate policy goals. Stocks and stabilization are means to the more fundamental end of promoting the economic well-being of farmers, consumers, and taxpayers. There are several controversial issues involving the role of stocks and stabilization in promoting these economic interests. Consumers and producers can lose as well as gain from price stabilization. Moreover, when

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storage is costly, benefits to consumers and producers added together may be less than the costs of the stabilization program to the Government--ultimately, the taxpayers. In that case, the FOR program could conceivably be rated a success in terms of promoting greater stockholding and more price stabilization, yet a failure in that its costs could outweigh the benefits. Sections 2 to 6 concentrate on assessing the FOR in terms of its immediate objectives-- the promotion of stockholding by farmers and greater price stability. The final two sections consider the overall social-welfare effects and policy alternatives for the future course of the FOR program.

SECTION 2

DETECTION OF FOR's EFFECTS: MODEL OF UNDERLYING

SUPPLY/DEMAND RELATIONSHIPS

This section discusses the problem of detecting the effects of the FOR in a market context in which non-FOR private storage exists prior to and along with FOR stocks. Because private storage depends on the general situation in the grain markets, a complete model of these markets is necessary to predict the size of grain stocks in the absence of the FOR, and hence to assess the net change in stocks caused by the FOR. Because a full econometric model with appropriate specifications of both speculative storage behavior and incorporation of related markets (livestock and other crops) has never been developed, and is beyond the scope of this research, some simplification is necessary. The approach taken is to concentrate on developing an empirically tractable model of private grain stockholding behavior, without detailed treatment of related markets. This section lays out the model in general terms and defends the approach taken.

The quantities and timing of grain placed in the FOR during its first 3 years are well known. (See tables 1 and 2.) It might therefore seem relatively simple to estimate the addition to U.S. grain stocks and resulting price impacts of the FOR program. Unfortunately, it is not. The main reason is that the holders of non-FOR stocks will adjust their holdings in the presence of the FOR. These adjustments will tend to reduce, and could completely offset the effects of FOR stock acquisition and release on total (FOR plus non-FOR) stocks, and thus reduce or nullify the effects of the FOR program on prices. Any estimate of net FOR effects must be somewhat conjectural, since we are investigating a counterfactual situation--what would private storage have been in 1977-79 without the FOR? The reliability of our answer depends on our ability to specify the relevant behavioral characteristics of farmers and others in the private grain trade. The relevant behavioral characteristics can be examined in an economic model of the grain markets. The general form of such a model that seems most readily applicable to present purposes is as follows.

First, the supply of grain available in year t [S(t)] consists of production [X(t)] and carryover stocks from the preceding year [I(t-1)]:

$$(1) \quad S(t) = X(t) + I(t-1).$$

Table 1

Quarterly Ending Stocks

Year and quarter (note a)	Wheat				Corn			
	Total	Private (note b)	CCC (note c)	FOR	Total	Private (note b)	CCC (note c)	FOR
				(million bushels)				
1972:3	1871	1692	179	0	1127	970	156	0
1972:4	1399	1235	164	0	4834	4718	116	0
1973:1	927	890	37	0	3342	3327	16	0
1973:2	597	591	6	0	2441	2441	0	0
1973:3	1452	1447	5	0	708	704	4	0
1973:4	928	923	5	0	4488	4483	4	0
1974:1	548	545	3	0	2870	2866	4	0
1974:2	341	340	1	0	1903	1900	3	0
1974:3	1562	1562	0	0	484	484	0	0
1974:4	1108	1108	0	0	3641	3641	0	0
1975:1	662	662	0	0	2228	2228	0	0
1975:2	435	435	0	0	1505	1505	0	0
1975:3	1885	1885	0	0	361	361	0	0
1975:4	1386	1386	0	0	4467	4467	0	0
1976:1	937	937	0	0	2833	2833	0	0
1976:2	665	665	0	0	1867	1867	0	0
1976:3	2188	2188	0	0	399	399	0	0
1976:4	1782	1782	0	0	4890	4890	0	0
1977:1	1390	1390	0	0	3293	3293	0	0
1977:2	1112	1112	0	0	2365	2365	0	0
1977:3	2400	2378	8	15	884	884	0	0
1977:4	1994	1898	32	64	5503	5503	0	0
1978:1	1528	1282	45	201	3877	3872	0	5
1978:2	1177	814	46	317	2837	2780	0	57
1978:3	2138	1707	49	382	1104	860	10	234
1978:4	1633	1183	50	400	6203	5512	62	629
1979:1	1226	771	50	405	4423	3603	92	728
1979:2	925	472	50	403	3232	2404	95	733
1979:3	2272	1972	50	250	1286	638	96	552
1979:4	1713	1433	50	230	6772	6088	97	586
1980:1	1225	908	63	254	4780	3862	101	817
1980:2	901	534	142	225	3586	2596	130	810

a/Following USDA convention, the first quarter is January through March; the second, April and May; the third, June through September; and the fourth, October through December.

b/Excluding FOR stocks.

c/Commodity Credit Corporation, USDA.

Sources: USDA, Agricultural Statistics, Wheat Situation, and Feed Situation, various dates.

Table 2

Annual Ending Stocks

Marketing year (note a)	Wheat			Corn	
	Privately owned	Government owned	Stocks as a proportion of supply (note b)	Privately owned	Government owned
	(million bushels)			(million bushels)	
1950	332	160	0.324	344	396
1951	247	82	0.221	196	291
1952	380	292	0.407	533	236
1953	279	714	0.538	572	348
1954	139	971	0.560	413	622
1955	209	922	0.551	416	748
1956	196	808	0.469	546	873
1957	149	813	0.490	423	1046
1958	284	1084	0.564	406	1118
1959	186	1198	0.556	502	1285
1960	278	1225	0.547	702	1315
1961	346	1074	0.519	842	810
1962	168	1102	0.505	798	567
1963	194	800	0.411	722	814
1964	286	635	0.404	626	522
1965	361	299	0.295	749	93
1966	391	122	0.260	690	136
1967	530	100	0.311	989	179
1968	765	140	0.413	828	290
1969	705	277	0.418	809	197
1970	470	353	0.352	570	97
1971	628	355	0.402	970	156
1972	591	6	0.235	704	4
1973	340	1	0.147	484	0
1974	435	0	0.204	361	0
1975	665	0	0.259	399	0
1976	1112	0	0.395	884	0
1977	1131	46	0.373	1094	10
1978	875	50	0.310	1190	96
1979	759	142	0.294	c/ 1350	c/ 250

a/Year beginning at time of harvest; taken to be June 1 for wheat, October 1 for corn.

b/Supply is production plus beginning (carryin) stocks.

c/Preliminary estimate.

Sources: USDA, Agricultural Statistics, Wheat Situation, and Feed Situation, various dates.

Planned production is a function of the price that had been expected at planting time [P*(t)], the expected prices of alternative products such as soybeans [R*(t)], input prices such as the price of fertilizer [W(t)], and other variables [T(t)] that represent technical or policy constraints such as an acreage-control program. R,W,T are vectors that represent a list of one or more variables. W and T do not have the * notation because their values can be observed at planting time and are not expected values of unknown variables. Actual production will turn out different from planned production because of random disturbances u(t), such as drought. Actual production is represented as

$$(2) \quad X(t) = f[P^*(t), R^*(t), W(t), T(t), u(t)].$$

On the demand side, there are two main categories of use of grain: current-period disappearance [D(t)] or storage for future use [I(t)]. Disappearance may take many forms, the most important of which are food production, animal feed, and exports. The demand for each use is a function of price and several demand-shifting variables. The most important of these are typically consumer income, population, livestock prices and quantities, and prices of substitute commodities (for U.S. domestic demand), and foreign market conditions, exchange rates, and policy variables such as trade barriers and farm policies of foreign countries (for export demand). Collecting these variables in the vector Z(t), disappearance is represented as

$$(3) \quad D(t) = g[P(t), R(t), Z(t), v(t)],$$

where v(t) represents random disturbances such as weather abroad.

The demand for stocks, the second main category of grain use, is more difficult to conceptualize. But it is crucial for investigating the effects of the FOR program, because the program will inevitably shift the demand for stocks. Although the quantity of stocks held by the private trade can be expressed as a function of current price, it is not an ordinary demand curve like equation (3). The expected gains from stockholding depend not only on current price, but on expected price next period, P*(t+1). And we cannot arbitrarily hold P*(t+1) constant while observing the response of I(t) to P(t), because a change of I(t) necessarily increases supply available in period t+1 and therefore necessarily decreases P*(t+1). Therefore, it does not make sense to refer to the effect of P(t) on I(t), holding P*(t+1) constant, even though it is tempting to interpret a plot of I(t) against P(t) in this way.

Consequently, the demand for stocks is best specified not analogously to equation (3), but in terms of the market equilibrium conditions. Private stocks will be increased if the present value of expected future returns at the margin exceeds the marginal cost of stocks. The basic component of expected returns to storage of I(t) is the expected price for which grain can be sold in the next year, P*(t+1). The marginal cost is the price paid in the current year, P(t), plus the marginal costs of storage, SC(t).

The equilibrium condition for carryover storage in a competitive market under an assumption of risk neutrality can be written as

$$(4) \quad P*(t+1) - P(t) = SC(t).$$

SC(t) is the full marginal cost of storage per unit of grain stored. It includes the rental value of storage space, the variable costs associated with placing grain in storage and maintaining its condition, interest costs, and the insurance value of having grain stocks on hand. What the equilibrium condition says is that private interests will add to stocks so long as expectations of profit exist, so that the equilibrium quantity of stocks is the quantity just sufficient to drive expected speculative profits to zero.

Since the quantity in stocks must equal the difference between supply and disappearance, we have the following adding-up condition:

$$(5) \quad S(t) = D(t) + I(t).$$

The system of equations (1) to (5) can be reduced to a more compact model of supply/demand equilibrium by the following steps. First, substitute (2) into (1) to eliminate X(t). Then substitute (5) into (1) to eliminate S(t). The market-clearing condition that quantity supplied equals quantity demanded at the equilibrium price permits the replacement of D(t) by Q(t) in both supply and demand equations. We thus have a 3-equation system consisting of a supply equation, a demand equation, and the price relationship (4). The three equations contain 4 mutually determined (endogenous) variables [D(t), P(t), P*(t+1), and I(t)] and thus do not in general determine unique values for any of them.

There are two ways to close the system so that it may be solved for equilibrium values of the endogenous variables. One can impose a long-run equilibrium condition, or one can go further in specifying storage behavior in order to complete a short-run equilibrium model. For present purposes, it is necessary to take the latter approach. Grain storage

is essentially a short-term adjustment mechanism under conditions of uncertainty. A model that seeks to explain the effects of governmental intervention in stockholding must therefore treat short-term stock adjustments explicitly. However, it may help in understanding the short-run model to discuss the underlying long-run equilibrium model first.

The simplest and most reasonable way to impose long-run equilibrium is to assume rational expectations--that the $P^*(t)$, the expected price in the psychological (behavioral) sense, is the same as $E[P(t)]$, the expected price in the statistical sense, given the information available each year at the time production decisions are being made. This allows us to use $E[P(t)]$, denoted by $\bar{P}$, in both the supply and demand equations, eliminating $P^*(t)$. Similarly, $R^*(t)$ and $R(t)$ are both equal to $\bar{R}$.

In addition, in the long run the expected value of change in stocks must be zero. (Otherwise stocks would either accumulate indefinitely or go to zero.) Therefore, the variable for stock drawdown, $I(t-1) - I(t)$, which appears as an element of supply after the substitutions described above, is zero in the long-run equilibrium depiction.

The resulting model, linearized for compact presentation, is:

$$
\begin{bmatrix} 1 & \gamma_{12} \\ \gamma_{21} & 1 \end{bmatrix}
\begin{bmatrix} \bar{Q} \\ \bar{P} \end{bmatrix}
=
\begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} & \beta_{13} & 0 \\ \beta_{20} & \beta_{21} & 0 & 0 & \beta_{24} \end{bmatrix}
\begin{bmatrix} 1 \\ \bar{R} \\ \bar{W} \\ \bar{T} \\ \bar{Z} \end{bmatrix}
$$

The omission of the t subscript is for convenience in presenting the model. If the expected values of the variables were constant over time, we would have stationarity. In general, one would want to allow for nonstationarity--change over time in the long-run equilibrium values of variables. However, the price-stabilization problem that the FOR is intended to solve is much the same under either stationarity or nonstationarity.

In long-run equilibrium we have two equations, a supply equation and a demand equation, in two endogenous variables, $\bar{P}$ and $\bar{Q}$, expected market-clearing price and quantity   Both

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are functions of the expected values of exogenous variables which influence $\bar{P}$ and $\bar{Q}$ but are not significantly influenced by them, notably income, other product prices, population, livestock numbers, foreign production, exchange rates, input prices, and policy parameters. Some of these, particularly other product prices, input prices, and livestock variables, may be endogenous (mutually determined with grain market variables). To account for such endogeneity, one must incorporate supply and demand functions for these substitute crop and livestock products, and one is led ultimately to large econometric models beyond the scope of this research.

Consider now short-run equilibrium incorporating market behavior in stockholding. At the beginning of each period t, X(t), and I(t-1) are determined, and hence may be taken as exogenous variables. Therefore, supply is exogenous and demand determines price. Supply varies randomly, and this creates the fundamental incentive for stockholding. The demand for stocks becomes an important component of total demand during high-production years, and hence helps to support P(t) during those years. Gustafson showed that when year-to-year fluctuations are due to random variations in production around a fixed mean, and demand and storage costs are constant, profit-seeking stockholding results in a storage function in which ending stocks are a function of beginning supply only. 1/ Pliska provides a more general depiction of the existence and basic properties of the multiperiod equilibrium and its relationship to holding stocks. 2/

The model of market equilibrium that contains explicit treatment of stockholding behavior includes four equations in addition to (1) to (5). One is a supply of storage function that relates the marginal cost of storage to quantity held in stocks:

$$(6) \quad SC(t) = h[I(t), PI(t)]$$

where PI(t) represents input prices and interest rates affecting storage. The second is the negative relationship

1/R.L. Gustafson, "Carryover Levels for Grains," Technical Bulletin No. 1178, USDA, 1958.

2/S.R. Pliska, "Supply of Storage Theory and Commodity Equilibrium Prices with Stochastic Production," _American Journal of Agricultural Economics_, Vol. 55, Aug. 1973, pp. 653-658.

between this period's ending stocks and next period's expected price:

$$(7) \quad P^*(t+1) = b[I(t), X^*(t+1)].$$

The third is equation (2) applied to determine $X^*(t+1)$.

Finally, the fourth equation introduces FOR stocks, $IF(t)$. They are a function of the net FOR subsidy available, $FS(t)$, as well as $PI(t)$, and the difference between $P^*(t+1)$ and $P(t)$:

$$IF(t) = c[FS(t), PI(t), DP^*(t)],$$

where $DP^*(t) = P^*(t+1) - P(t)$. This equation could have been expressed analogously to equilibrium condition (4). The implication is that $P^*(t+1) - P(t)$ would be driven down to $SC(t) - FS(t)$, storage costs minus the subsidy. With subsidies of the magnitude that the FOR has provided, this would eliminate expected profits for unsubsidized storage. However, constraints on the subsidies--the 3-year holding period, other program requirements--leave room for private stocks outside the FOR. Therefore, we maintain the equilibrium condition of equation (4). The effect of FOR stocks on other variables in the system is modeled by including $IF(t)$ in equations (5) and (7). Equation (5) incorporates the influence of the FOR on current consumption flows and hence on $P(t)$. Equation (7) brings in the FOR's influence on next period's expected supply and hence on $P^*(t+1)$. Of course, in the equilibrium of the system, $I(t)$ will tend to react to changes in $IF(t)$ in the opposite direction and this will moderate the price effects of the FOR. Thus, changes in the policy parameters in $FS(t)$ will have effects throughout the system. Our goal is to estimate some of these effects.

The model sketched out in the preceding paragraph can be compactly presented in a linearized form as follows: [1]/

$$
\begin{bmatrix}
1 & 0 & -\gamma_{13} & 0 & 0 \\
0 & 1 & 0 & -\gamma_{24} & 0 \\
0 & 1 & 1 & 0 & 0 \\
-1 & -\gamma_{42} & 0 & 1 & 0 \\
0 & 0 & 0 & -\gamma_{54} & 1
\end{bmatrix}
\begin{bmatrix}
P(t) \\
I(t) \\
D(t) \\
P^*(t+1) \\
X^*(t+1)
\end{bmatrix}
=
$$

$$
\begin{bmatrix}
\beta_{10} & \beta_{11} & \beta_{12} & 0 & 0 & 0 \\
\beta_{20} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 \\
\beta_{40} & 0 & 0 & 0 & \beta_{45} & 0 \\
\beta_{50} & 0 & 0 & 0 & 0 & \beta_{56}
\end{bmatrix}
\begin{bmatrix}
1 \\
R(t) \\
Z(t) \\
S(t) \\
PI(t) \\
TW(t)
\end{bmatrix}
$$

This system of equations is obtained by substituting equation (6) into (4) to eliminate $SC(t)$. The timing of t after production as determined allows (1) and (2) to be eliminated, and $S(t)$ to be taken as an exogenous variable. The endogenous variables are on the left and the exogenous variables are on the right. The variables are all defined above except for $TW(t)$, which is a vector combining $R^*(t)$, $W(t)$, and $T(t)$. $R(t)$, $Z(t)$, and $PI(t)$ are also, in general, vectors along with the corresponding β_{ij}.

A full-fledged econometric model of this system would have to consider all these variables and would need to specify the error structure. Moreover, it would have to consider cross-commodity simultaneous determination of market equilibrium

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[1]/This model is discussed in detail in B. Gardner, "Public Stocks of Grain and the Market for Grain Storage," in G. Rausser, ed., "New Directions in Econometrics Modeling and Forecasting in U.S. Agriculture," North Holland, forthcoming.

with related commodities, introducing the R(t) as endogenous variables. And for short-term price movements, the dynamics of adjustment to shifts in exogenous variables would have to be modeled explicitly.

Consequently, the full analysis of period-to-period price changes and stock adjustm... ...uld require a research project even larger than ... ... , equilibrium models discussed earlier. The c... ... existing approximations to such a model are commercially developed models such as those of Chase Econometrics and Wharton Econometric Forecasting Associates. But these models are aimed at prediction, not at representation of behavioral relationships in ways that permit analyzing counterfactual questions such as: What would have happened in 1977-80 in the absence of the FOR program? In particular, the equations incorporating private grain storage behavior are not sufficiently developed for present purposes. Moreover, the parameters of pre-estimated equations cannot be assumed invariant to the FOR policy regime. The most important parameters, those describing speculative holding of stocks by private individuals, are likely to be especially sensitive to governmental holding of stocks. Thus, existing econometric models are likely to be unreliable sources for estimating FOR effects. Unfortunately, building a correctly specified full model is far beyond the possibilities of this research.

The more modest approach that will be taken is to begin with the simplest possible representation of storage behavior and add complications as necessary to estimate FOR effects reasonably. The simplest representation is that of Gustafson (op. cit.) which explains the level of stocks as a "storage rule" in which I(t) is a function of S(t). From the list of endogenous and exogenous variables in the full model, we see that I(t) is endogenous and S(t) is exogenous. Thus, we have a primitive reduced-form equation from the full linearized system. It will not be a useful equation if it excludes important exogenous variables. The main such variables to be explored in this research are policy variables associated with the FOR program. To judge the applicability of slightly more complicated variants of this type of storage rule, we turn to the actual data for corn and wheat.

FOR's EFFECT ON GRAIN STOCKS: ANNUAL DATA

This section contains estimates of the FOR's effects on ending stocks of wheat and corn in the marketing years beginning in 1977, 1978, and 1979. First, a simple graphical depiction is given which shows no apparent increase in ending stocks in the FOR years as compared with a simple storage function for the pre-FOR years, 1972-76. However, regression estimates for a longer time period suggest that the FOR may have added 1 bushel of wheat to total stocks for each 4 bushels in the FOR, and 1 bushel of corn to total stocks for each 3 bushels in the FOR.

Figures 1 and 1A show U.S. total (public and private) carryover stocks of wheat and corn plotted against supply available at the beginning of each year. A simple least-squares regression line has been drawn in. This is a linear representation of a storage rule. 1/ Its slope determines the "marginal rate of stockpiling," the percentage of each added bushel of grain that goes into stocks. For wheat the slope indicates that for each 100 bushels added to the U.S. supply, about 85 bushels is added to stocks. This implies that only 15 bushels is added to domestic consumption or exports. The slope of the corn storage rule suggests that for each 100 bushels added to supply, about 50 bushels goes into carryover stocks. This behavior suggests forward-looking behavior in that the stored grain will be available for future years when supplies will be lower and stocks are drawn down.
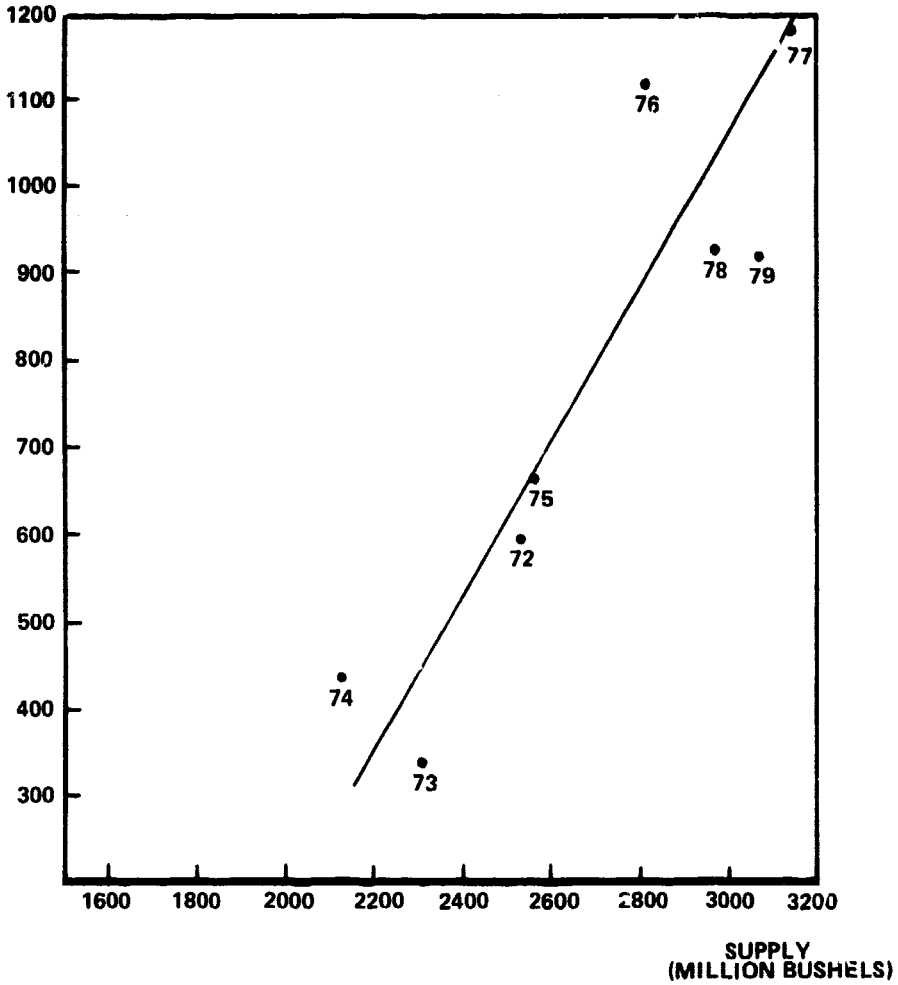
While the storage rule is linear, it does not pass through the origin. Stocks are totally used before supply

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1/ Storage rules will not in general be linear, but no apparent departures from linearity are in this particular data.
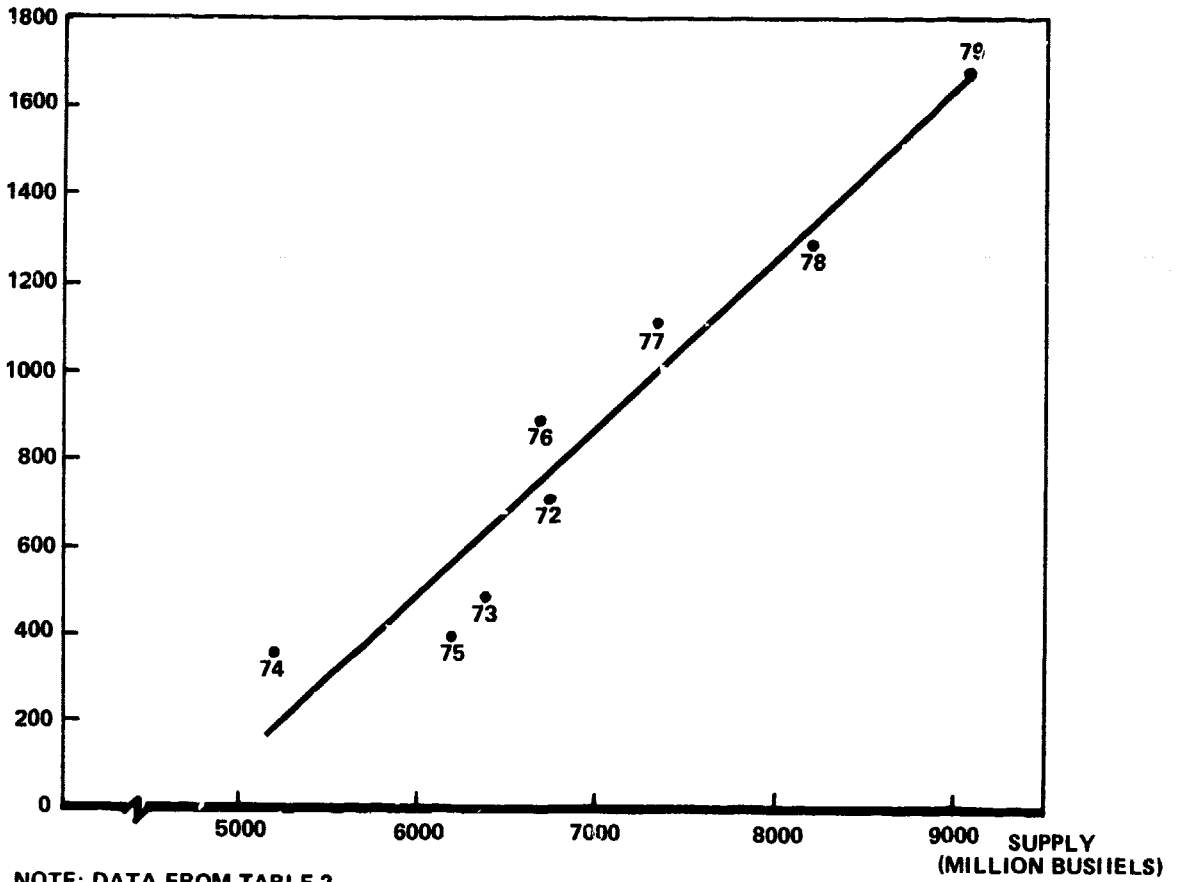
FIGURE 1

WHEAT STOCKS AND SUPPLY

NOTE: DATA FROM TABLE 2.

FIGURE 1A
CORN STOCKS AND SUPPLY

CARRYOVER STOCKS
(MILLION BUSHELS)

NOTE: DATA FROM TABLE 2.

SUPPLY
(MILLION BUSHELS)

becomes much lower than mean annual production. 1/ However, stocks in practice never decline to zero. Their lowest levels in the post-World War II years were the points shown in 1973 for wheat and 1974 for corn. The smallest stock levels are referred to as "pipeline" stocks. They are necessary to insure the availability of grain to feed and process during the transition from one crop year to the next. They are not used up in consumption even in years of substantial shortage, such as in the 1973-75 period, even though prices are relatively high. Stocks held in hopes of a price rise essentially disappear in such periods, because price is more likely to fall than rise in subsequent years.

The FOR's effect in increasing carryover stocks should show up in a larger total carryover during those years when the FOR was encouraging stockholding. Graphically, this means that the points labeled "77", "78", and "79" should lie above the storage rule fit over the entire data set. 2/ They do not. It would be very premature, however, to conclude that the FOR did not promote stockholding. The FOR period was different from the pre-FOR period in that supplies were generally larger. We cannot be confident that a storage function fit to pre-FOR data points could be extended linearly so far past the range of pre-FOR data, especially for corn.

More fundamentally, while a simple storage function can be viewed as a part of a reduced-form equation from the

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1/For this reason, one must be careful to avoid associating the percentage of supply carried in stocks with the marginal rate of stockpiling. This average rate of stockpiling is much lower than the marginal rate. Thus, the marginal rate of wheat storage in figure 1 is 0.85, while stocks as a proportion of supply ranged from 0.15 to 0.40 in 1972-79 (table 2). One must also be careful with the ratio of stocks to disappearance, sometimes used as an indicator of "tightness" of grain markets. Because disappearance is an endogenous variable, mutually determined with carryover stocks, while supply is predetermined (exogenous, as discussed in section 2), the ratio of stocks to supply has advantages for present purposes.

2/The years in the labels represent crop years. Thus, the year "77" for wheat runs from June 1, 1977, to May 31, 1978, and the carryover stocks plotted are for the latter date. The corn crop year begins in October and ends in September. The FOR program was announced in the spring of 1977, and was well under way before the end of the 1977 crop years for both wheat and corn.

general model discussed at the end of the preceding chapter, all the exogenous variables other than S(t), are left out. This could bias the estimated FOR effect. The left-out exogenous variables are elements of the vectors R(t), TW(t), Z(t), and PI(t), which are shifters of grain demand, grain supply, storage costs, and predetermined elements of the policy regime that influence the grain market. So long as these variables are all held constant, the simple storage rule should be relatively stable. 1/ Moreover, even if the structure of the market changes over time, the storage rule will be stable if these changes follow a steady trend. 2/

These considerations suggest that we might at least try fitting simple storage rules for longer periods of time, in order to obtain a better estimate of pre-FOR stockholding behavior. However, use of data prior to 1972 creates a substantial structural discontinuity in that a quite different policy environment existed. The relevant aspect of this policy regime for present purposes is the substantial governmental holding of stocks by USDA's Commodity Credit Corporation (CCC).

In order to take a second, more quantitative cut at estimating FOR effects, consider the following regression. It explains total ending stocks of wheat, IE, as a function of (1) beginning supply, S, (2) Government ending stocks, IEG, and (3) FOR stocks, IFOR:

$$IE = -223 + 0.37S + 0.58IEG + 0.26IFOR.$$
$$(5.0) \quad (9.6) \quad (0.8)$$

(Figures in parentheses in this and subsequent equations are absolute values of t ratios.) This equation explains 85 percent of the year-to-year variability in stocks from

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1/Even if the behavioral parameters are constant, the storage rule will change if the stochastic processes generating u(t) and v(t) change; for example, if weather becomes more variable. Such changes are difficult to detect in the absence of a quite long time series, however, and no evidence exists that 1977-80 is different from 1972-76 in this respect (even though the specific realizations of the stochastic processes may well have been different).

2/For more detailed treatment of this point, see Gustafson, op. cit., and B. Gardner, "Optimal Stockpiling of Grain," Lexington Books, 1979.

1950-51 to 1978-79. This indicates considerable stability in the storage function. There is not a lot of variance in storage remaining for omitted variables to explain. The meaning of the S coefficient is that a 1-bushel increase in supply increases stocks on average by 0.37 bushel. Similarly, the coefficient of IEG means that a 1-bushel increase in Government stocks (CCC stocks) adds 0.58 bushel to stocks. 1/ The reason CCC stocks added only 0.58 bushel to total stocks is that they displaced an estimated average of 0.42 bushel of private stocks that would otherwise have been held.

The IFOR coefficient means that each bushel of wheat in the FOR program added 0.26 bushel to total stocks. Thus, 400 million bushels in the FOR is estimated to add roughly 100 million bushels to total carryover stocks. However, the 0.8 t ratio indicates a statistically weak relationship. One cannot confidently reject the hypothesis that FOR stocks have had no effect on carryover stocks.

It may be thought that the most important aspect of the FOR program was not the level of FOR stocks but simply the program's existence. The very announcement of the program may be taken to mean that the Government is committed to supporting market prices. This encourages private speculative stockholding by reducing the risk of capital loss due to a drastic price decline. Introducing a dummy variable, FOR, equal to 1 when the FOR program was in effect and zero otherwise, generates the following results:

$$IE = -207 + 0.36S + 0.58IEG + 114FOR.$$
$$(4.9) \quad (9.7) \quad (1.0)$$

The coefficient of FOR says that the existence of the FOR program increased ending stocks by 114 million bushels on average during the 3 completed marketing years when it was in existence (1977-78, 1978-79, and 1979-80). Since the average year-end FOR stock level was 360 million bushels, the equation indicates that a little more than 3 bushels must go into FOR stocks in order to add 1 bushel to total

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1/The higher coefficient on CCC stocks does not imply that CCC storage, if it replaced the FOR today, would generate a smaller reduction in nonprogram stocks than the FOR. The reason for the higher CCC coefficient is that during the 1950s and 1960s, CCC stocks in many years replaced essentially all private stocks above working stocks, so that additions to CCC stocks necessarily added substantially to total stocks.

stocks. Thus, it appears that the existence of the FOR program has some effect, although small, on promoting stocks over and above the level of FOR stocks. As in the earlier regression, however, the FOR variable is statistically weak. This weakness could be due to the existence of only 3 years out of 29 considered in which the FOR was in effect. It is the statistical means of saying that while the FOR program appears to have a positive effect on stocks, we cannot measure this effect confidently given the information available from year-end carryover stocks.

Taking as the most likely rough estimate that the FOR program adds 1 bushel to total stocks for every 4 bushels in FOR stocks, the program must be reducing ordinary privately held stocks by 3/4 bushel for each bushel in FOR stocks. The relevant regressions are:

$$IEP = -223 + 0.37S - 0.42IEG - .74IFOR,$$
$$(5.0) (7.0) (2.2)$$

$$IEP = -213 + 0.37S - 0.42IEG - 248FOR,$$
$$(4.8) (6.8) (2.0)$$

where IEP is private ending stocks outside the FOR program. The first regression says that each bushel in FOR ending stocks reduces stocks held outside the FOR by 0.74 bushel. This is the same as saying that it takes 4 bushels in the FOR to add 1 bushel to total stocks. The second regression says that the existence of the program has, on average, reduced private stocks outside the FOR by 248 million bushels.

The following regression estimates the effect of the FOR program on carryover stocks of corn:

$$IE = -50.6 + 0.13S + 1.0IEG + 0.39IFOR.$$
$$(3.8) (12.2) (1.1)$$

As in the wheat regressions, S refers to beginning supply, IEG to CCC stocks, and IFOR to the quantity of FOR stocks. This equation explains 86 percent of the variance of stocks, virtually the same as for the wheat equation. However, CCC stocks and FOR stocks both appear to be more effective in adding to total stocks for corn than for wheat, although the differences between the IFOR coefficients in the wheat and corn equations are not statistically significant. The IFOR coefficient of 0.39 in the corn equation is in fact not significantly different from zero. The point estimate suggests that a 1-bushel addition to the FOR increases total stocks by about 0.4 bushel; in other words, it takes 2.5 bushels in the FOR to increase stocks by 1 bushel.

Estimating the same equation except replacing IFOR by an FOR dummy = 1 when the program was in effect yielded an FOR effect of 191 million bushels (t = 1.3). Since the mean ending FOR corn stock was 405 million bushels, this equation indicates that a bushel in the FOR added 191/405 = 0.47 of a bushel to total corn stocks. Thus, the point estimates indicate that the FOR was slightly more effective in increasing corn than wheat stocks. While one should not make too much of differences in these weakly significant coefficients, a larger corn-stock effect of the FOR could be the result of the fact that pre-FOR stocks were much larger relative to supply for wheat than for corn.

While the preceding results are suggestive, the regressions involve analytical difficulties that reduce confidence in the point estimates of FOR program effects. Two difficulties are: (1) the fact that the FOR "experiment" was in effect for only 3 years in the 1950-80 period and (2) the issue of what other variables should be held constant to measure FOR effects.

This second difficulty involves not only left-out variables but also the fact that IEG and IFOR are endogenous. They are determined during the market year, simultaneously with IE, and therefore may be influenced by as well as influencing IE. The storage rule was advertised as a primitive reduced-form equation, but as estimated, it is not. It may be argued that the ordinary least squares (OLS) estimation of this as a structural equation is unlikely to be drastically misleading, principally because the FOR dummy specification is clearly exogenous, and it shows an FOR effect on total stocks of the same order of magnitude as the IFOR variable. Nonetheless, we should consider the possibility of trying to incorporate some simultaneity in the estimating equations.

It is perhaps even more important to consider the incorporation of left-out exogenous variables likely to have taken on different values in the FOR period than in earlier years. The most likely candidates are shifters of the export component of U.S. grain demand. These include foreign grain production, changes in currency exchange rates, and changes in commodity policy abroad. There were in fact substantial changes in all three of these in the 1970s that could not be movements along relatively smooth trends that leave the storage rule stable. Foreign production changes randomly from year to year just as U.S. production does. Foreign currency exchange rates were subject to one-time substantial revaluation relative to the dollar in the early 1970s, and have varied since in ways that may have affected U.S. grain exports. These events could result in substantial short-term

shifts in the storage rule which could lead to spurious
FOR effects, or could mask FOR effects that actually exist.

For example, if the years in which the FOR program
operated were characterized by unusually strong export
demand, then the lack of significantly higher stocks associa-
ted with FOR in the regressions and in figure 1 could be a
consequence of the export situation and not of the FOR pro-
gram. To illustrate, U.S. wheat exports averaged 130 million
bushels more during 1977-79 than during 1972-76. If this
indicates a transitory increase in exports during the FOR
period, it should have caused a decrease in carryover stocks
just as a random U.S. production shortfall would have.
Looking at figure 1, if a marginal rate of stockpiling of
0.85 is correct, then the FOR years should show 130 x 0.85 =
110 million bushels less in carryover stocks, compared with
the simple regression line. An upward adjustment of this
magnitude would place the FOR years roughly on the regression
line, removing the anomaly of smaller stocks in the FOR years
(although we still do not obtain significant positive effects
of the FOR on stocks).

Similar problems in specifying the storage rule could
result from year-to-year shifts in domestic grain demand
because of conditions in the livestock markets.

With respect to the PI(t) variables, the one most likely
to have shifted storage costs on an annual basis is the
interest rate--the opportunity cost of tying up funds in
grain. However, as argued in Gardner (op. cit.), the rele-
vant rate of interest is the real rate, the observed market
rate of interest minus the expected rate of inflation. We
do not have good data on real interest rates, or on their
fluctuations from year to year.

These considerations lead to the necessity of estimating
a more complete model such as the one outlined in section 2.
In taking this route, however, the following serious dilemma
arises. In trying to add more variables to the equations
explaining stocks, we quickly use up our degrees of freedom
in a short series such as the 8-year 1972-79 period. Yet
if we take a longer period, there are so many additional
structural changes to be taken into account, especially for
the pre-1972 period as compared with 1972-79, that there is
serious question whether the structure of the grain markets
was sufficiently similar to the FOR period that pre-1972
storage behavior has any informational content in estimating
what 1977-79 behavior would have been without the FOR.
Investigating these structural changes adequately would
again involve a much larger research project than the present

effort. Besides, this model would be likely to use up most of the degrees of freedom in, say, the 30 years of 1950-79 data, making conclusive tests of FOR hypothesis difficult to obtain.

In an attempt to obtain more evidence to work with while not going so far back in time, we now turn to quarterly data.

SECTION 4

FOR's EFFECT ON GRAIN STOCKS: QUARTERLY DATA

This section examines a quarterly econometric specification of grain storage behavior. The equations bring in more of the data necessary for a complete model of the grain sector. The resulting FOR effects estimated are even smaller than in the annual data. The largest effect found indicates that for corn and wheat jointly, it takes 5 bushels in the FOR to generate one additional bushel of total stocks. The section ends with a discussion of the reasons for a small FOR effect.

Quarterly data create possibilities for more sensitive testing of hypotheses about the FOR program. The program was introduced during the last quarter of the 1976-77 marketing year for wheat. Thus, it may have affected stocks on May 31, 1977, but not on March 31, 1977, December 31, 1976, or September 30, 1976. Beginning in the 1977 marketing year, we have data for 12 quarters (1977:II through 1980:I) in which the program has existed. The econometric problem is to estimate how the program influences stockholding behavior during this time.

The use of quarterly data involves new complications, in that stocks are held seasonally during post-harvest quarters for normal use during later quarters. This creates a strong seasonal pattern that must be accounted for in the regression analysis. This is accomplished by using dummy variables that take on the value 1 in the first, second, and third quarters of the marketing year, respectively. Their coefficients indicate differences in ending stocks for each quarter. The differences show the differing rates of consumption and exports in the quarters. Normally, the rate of disappearance is higher early in the marketing year. In addition, because the wheat marketing year begins on June 1, one "quarter" contains only 2 months (April and May), while another (June to September) has 4 months and also tends to have greater consumption of wheat because wheat tends to be seasonally abundant relative to other grains in this quarter and is used to some extent in livestock feeding.

The quarterly data suggests a slightly different approach to aggregating wheat and corn (and other grains) to obtain stock data for grains. In the annual data, carryover stocks for grains are obtained by adding wheat and corn stocks observed at different dates (May 31 and September 30). But in analyzing stocks carried from one quarter to the next, this approach is inappropriate.

No quarter ends with only minimal old-crop and negligible new-crop grain available. Therefore, none of the quarterly observations considers year-to-year carryover stocks for all grain. However, for corn and wheat analyzed separately, the June-September and April-May ending stocks can be taken as estimates of the year-to-year carryover.

Section 2 discussed characteristics that a full model for estimating FOR effects should have. Section 3 considered a few very simple models which generated suggestive results. This section can be considered as an attempt to move beyond the weaknesses of the simple models toward the features of a full model, but without becoming involved in an impossibly large and complex research project. The strategy is to incorporate the most important features of the full model and hold the inevitable compromises to relatively inessential features. Of course, a substantial ingredient of judgment (or guesswork) is involved in deciding which features are important and unimportant.

The features that it seems essential to include are an explicit modeling of exports and some elements of mutual determination. The latter is especially important when exports are included in the model. To see the problem, suppose that the FOR program increases private stockholding. The increased stocks must be taken from consumption channels, one of which is exports. Thus, it could be that exports are smaller in FOR years because of the program, so that including exports in the stocks equation biases the FOR variable. This sort of situation is expressed by considering exports as an endogenous variable in our model. What we should have in our equations is the exogenous component of export demand—the aspects of the export market that influence but are not influenced by ending stocks (and price) in the current quarter.

Unfortunately, econometric modeling of U.S. grain export demand has not to date produced estimated equations in which one can have much confidence. It would be hopeless to try to remedy this lack here. Instead, exports are modeled using time series techniques in which the exogenous variables are lagged values of exports. The underlying assumption is that all we can know about current-period export demand at the beginning of a quarter is contained in the time series of past exports and prices. Because this rather mechanical approach is ultimately unsatisfactory from the point of view of economic theory, a model using current-period exports as an explanatory variable, ignoring the simultaneity problem, is also fitted to the data. Using two alternative estimating equations, each with potentially

serious problems, allows sharper conclusions to be drawn than might be expected, as shown below.

Table 3 presents results for two-stage least squares (2SLS) estimates of a small-scale simultaneous equations model. The exogenous variables are beginning supply in each quarter, eight quarterly lagged values of exports, quarterly dummy variables, and exogenous FOR dummies. The endogenous variables are the levels of total ending stocks for each quarter, CCC stocks, and FOR stocks.

Each line of the table shows the results of a different variant of the model. For example, line 1 gives the coefficients of the regression:

$$IE = -184 + .98S - .91E - 18FOR,$$

where S is quarterly beginning supply, E is exports, and FOR is a dummy variable = 1 only in the 12 quarters from April 1977 through March 1980. The coefficients of S and E mean that a 1-bushel addition to supply increases stocks by 0.98 bushel and a 1-bushel addition to exports decreases stocks to 0.91 bushel. The coefficient of FOR means that stocks averaged 18 million bushels less during the FOR period than in the pre-FOR period, other things being equal. The FOR effect is not significantly different from zero.

The remaining lines of table 3 show alternative regression results. Each contains quarterly dummy variables whose coefficients are not shown. The quarterly dummies are intended to remove seasonal factors so that the quarterly regressions will generate results comparable to those presented earlier for annual data. Nonetheless, it is not certain that an appropriate specification for this purpose has been obtained. Specifications without quarterly dummies were tried, but generated essentially the same estimated FOR effects.

The first two regressions of each commodity set (1-2 for wheat, 5-6 for corn, and 9-10 for "grain") differ only in that one uses OLS estimation, which is more straightforward statistically but may generate biased coefficients. The bias should result in overstating the negative association between exports and ending stocks, given beginning supply. (If less is exported during a quarter, the reduction must necessarily go into either ending stocks or domestic consumption channels.) Comparing the 2SLS estimates, the "t" value is lower than OLS for all three comparisons, and the coefficient on exports is nearer to zero for 2 out of the 3, with the exception of wheat. The problem

Table 3

Regression Coefficients (with t ratios) Explaining Quarterly Ending Stocks of Grain, 1972:II to 1980:I

Equation	Supply (S)	Exports (E)	IFOR	FOR	REL	NEP
1. Wheat(OLS)	0.98 (33.4)	-0.91 (8.2)		-18 (0.9)		
2. Wheat(2SLS)	0.98 (33.0)	-0.97 (6.4)		-15 (1.6)		
3. Wheat(2SLS)	0.97 (39.9)	-0.96 (5.9)	-0.04 (0.6)			
4. Wheat(2SLS)	0.98 (29.1)	-0.94 5.4		-9 (0.4)	-36 (1.1)	20 (0.4)
5. Corn(OLS)	0.84 (22.5)	-0.63 (2.9)		47 (0.6)		
6. Corn(2SLS)	0.84 (21.7	-0.43 (1.5)		16 (0.2)		
7. Corn(2SLS)	0.84 (20.1)	-0.43 (1.6)	0.04 (0.2)			
8. Corn(2SLS)	0.84 (19.4)	-0.19 (0.5)		-6 (0.1)	-127 (0.9)	125 (0.8)
9. Grain(OLS)	0.87 (21.2)	-0.86 (4.5)		103 (1.1)		
10. Grain(2SLS)	0.86 (18.5)	-0.64 (1.9)		88 (0.9)		
11. Grain(2SLS)	0.84 (14.4)	-0.81 (1.8)	0.20 (1.0)			
12. Grain(2SLS)	0.87 (16.2)	-0.38 (0.9)		57 (0.6)	-206 (1.5)	123 (0.6)

a/IFOR is the quarterly ending quantity, in millions of
  bushels, in the FOR. It is an endogenous variable in
  the 2SLS regressions. FOR, REL, and NEP are dummy variables.

with the 2SLS coefficient is that the instrument for exports is essentially a weighted average of past exports, and this may omit relevant information about shifts in current-period export demand that traders actually have. This is an omitted-variable problem and should lead to a coefficient on exports biased toward zero.

Thus, the OLS coefficient should overstate the effect of exports on stocks and the 2SLS coefficient should understate it. Together they should provide an upper and lower bound on the coefficient. The three pairs of coefficients relevant to this discussion are: -0.91, -0.97 (wheat equations 1 and 2); -0.63, -0.43 (corn equations 5 and 6); and -0.86, -0.64 (grain equations 9 and 10). In each pair, both specifications give reasonable signs and magnitudes, and in fact are statistically not significantly different. Therefore, it appears that neither the lagged-export specification or the OLS equation gives seriously biased results.

A remaining questionable aspect of the equations estimated is that they omit livestock/grain interactions and omit interaction with related crops. Regarding livestock, changes in the number of animals can generate year-to-year changes in feed demand which could shift the storage function just as export-demand shifts do. However, changes in livestock numbers are not nearly so unpredictable on a quarterly basis as changes in exports, and so leaving them out of the regressions is not so likely to bias FOR coefficients. Moreover, if a notable special characteristic of livestock numbers exists during the 1977-79 FOR period, it is most likely that for cattle at least, numbers are below trend. This would tend to increase stockholding above the normal storage function (just as weak export demand would). The result would be that the grain stock increase due to low cattle numbers would be attributed to the FOR variable. Thus, it seems most likely that leaving out the livestock sector would tend to overstate the estimated FOR effect on stocks, not understate it. Nonetheless, it would be more satisfactory to have the livestock sector explicitly incorporated in the econometric model. This is one of the contributions of the paper by Just. 1/

Interaction among grain markets implies that the R(t) variables should be included; for example, that the corn

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1/R.E. Just, "Theoretical and Empirical Considerations in Agricultural Buffer Stock Policy Under the Food and Agriculture Act of 1977," prepared for the U.S. General Accounting Office. (See vol. 3.)

supply be introduced in the equation explaining wheat stocks.
This was tried without significant results. Another approach
tried was to explore the possibility that interaction makes
a difference by aggregating wheat and corn and fitting the
model to both commodities jointly. When this is done, in
equations 9 to 12, the estimated FOR effects are increased
slightly.

No matter what the specification, the estimated effects
of the FOR program on stocks are smaller in the quarterly
data than in the annual data. The coefficients of FOR
(dummy variable = 1 from 1977:III through 1980:I) and IFOR
(quantity of FOR stocks) are both insignificantly different
from zero in both the wheat and corn regressions. The annual
regressions suggested that a bushel of wheat in the program
added about 0.25 bushel to total wheat stocks and a bushel
of corn added about 0.40 bushel to total corn stocks. But
the quarterly regressions result in rejection at the
1-percent confidence level of a null hypothesis that FOR
effects are this large. The corn-wheat aggregate regres-
sions suggest that a bushel in FOR stocks adds 0.20 bushel
to total stocks (from regression 11) or that the program
added an average of 103 million bushels to total stocks
during its 11 quarters of operation. Since FOR stocks
averaged about 750 million bushels, the implied net increase
in total stocks due to the program is 103/750 = 0.14 bushel
per bushel in the FOR; that is, it takes 7 bushels in the
FOR to add 1 bushel to total stocks. In summary, no matter
how we look at it, the quarterly data indicate less effec-
tiveness of the FOR than the regressions using annual data
discussed earlier.

The quarterly data permit separate treatment of the
period since mid-1979 when wheat and some feed grains went
into release status. The variable REL is a dummy variable
= 1 only in 1979:III, 1979:IV, and 1980:I. Its negative
coefficient indicates that total stocks were in fact reduced
by the measures taken to reduce FOR stocks, most notably the
cessation of storage payments on wheat. FOR stocks of all
grains were reduced by about 350 million bushels (based on
bushels of wheat: 1 bushel = 60 lbs.) during the last half
of 1979. The coefficients suggest that about half of the
grain released went into free private stocks.

The first quarter of 1980 calls for special considera-
tion in that measures were put in place to encourage stock-
holding in the wake of the suspension of grain sales to the
Soviet Union. The NEP variable is a dummy variable = 1 in
1980:I only. The positive coefficient in regressions 4, 8,
and 12 indicates in millions of bushels the estimated

addition to total stocks. However, since REL = 1 in 1980:I because wheat storage payments were still suspended, the net effect of policy in 1980:I is the sum of REL and NEP coefficients, which is practically zero. Thus, even though FOR stocks were increased by about 150 million bushels during the first quarter of 1980, this does not seem t' have any significant effect on total stocks. Of course, the statistical results are suspect because we have only one quarter when NEP = 1, so that any left-out factor that influenced 1980:I ending stocks would be attributed to the NEP coefficient.

In addition to the regressions reported in table 3, several alternative specifications with different time periods were tried, including CCC stock levels along with FOR stocks, adding other variables such as the loan rate (in real terms), the target price, and alternative specification of the dependent variable as a percentage of beginning supply in ending stocks. It is not clear that any particular one of these alternative specifications, or any of the particular regressions presented in table 3, is best from either an economic or statistical point of view. The important result is that taken together they tell a quite consistent story about the FOR program. The FOR variables have a consistently weak effect on ending stocks, never as great as in the annual regressions. The most optimistic estimate would be that it takes 4 bushels of grain in the FOR to add 1 bushel to total stocks, with most regression results suggesting even weaker effects in 1977:III to 1980:I.

How can it be that a program intended to stabilize prices by adding to stocks seems to have had such a small effect, or even no effect at all—especially when the program operates by providing payments to farmers who store grain? The most likely reasons are that the FOR, because of quirks in its administration, makes it inordinately easy for farmers to participate in the program yet not add to carryover stocks; and that the incentives for expanding storage at the margin are smaller than the size of storage payments suggests at first glance.

Current administration of the FOR makes it inordinately easy for farmers to participate in the program without adding to the Nation's carryover stocks. It must be kept in mind that during most of the marketing year, stocks are much larger than the carryover level. The key to long-term stabilization policy is to increase stocks that are not used up but are held through the new-crop harvesting season. If stocks are marketed before this time, they contribute nothing to year-to-year price stability. Yet the Agricultural

Stabilization and Conservation Service (ASCS) permits farmers who are short of storage space to take FOR grain out of storage just preceding harvest, to be replaced within 30 days by new-crop grain. With this provision the FOR program can become simply a within-year marketing tool, preferable to CCC loans because of the storage payments and interest subsidy. A farmer could participate in the program year after year, without ever adding a bushel to carryover stocks.

As a matter of fact, official permission from USDA's ASCS to sell old-crop FOR stocks at harvest and replace them with new-crop grain does not appear to have been widespread enough to negate carryover-stock effects of the FOR. However, there would be a temptation for farmers to do this informally, without ASCS permission. After all, if anyone from ASCS were to check, an extremely rare event in any case, the FOR storage space would be full at all times except for a few weeks around harvest time. We do not have data on the extent of this phenomenon, but it is one reason for the result of this section that U.S. total carryover stocks have not increased anywhere near as much as quantities of grain in the FOR would indicate at first glance.

Another reason for a smaller-than-expected FOR effect on stocks is that the incentives to increase stocks because of the subsidy payments is less than the size of the payments would indicate. First, the participant must agree to hold grain for 3 years, unless the release price is reached. Although we know now that grain was to be released before the period was over, farmers at the time the FOR program was implemented did not know this. While incentives existed that were sufficient to shift grain stocks into the FOR, the net expected gain may not have been much greater than for storage outside the FOR, so that the net incentives for additional total stocks were not great. 1/

Consider also the price-support effects of the FOR. As mentioned above, the price-support element of such a program would encourage private storage, apart from the existence of FOR stocks, because the risk of loss due to a fall in price is reduced. By the same token, however, the

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1/For more on storage incentives, see W.H. Meyers and R.W. Jolly, "Price Implications of Farmers' Response to the Farmer-Owned Reserve Program," presented at the 1980 meeting of the American Agriculture Economics Association, Urbana, Illinois.

price-dampening potential of the release and call of FOR stocks reduces the prospects for speculative gain from private storage. Moreover, the price support provided by the loan rate exists independently of the FOR program. (Regressions in which the loan rate is included as an independent variable indicate an even smaller FOR effect than in the regressions shown above.)

Therefore, the main new element added by the FOR program could be the potential for reducing speculative price gains. Reinforcing such a perception could be a belief among farmers that FOR stocks management will partially replace supply management via set-asides as a price-support mechanism. Set-asides support current prices without the accumulation of stocks that reduce the prospects for higher prices in the future. To the extent that the FOR program reduces the likelihood of set-asides in the future, it reduces to some extent the incentives for private stock-holding. (This is not to say that set-asides are a desirable policy. Indeed, it is probably preferable to have storage programs without set-asides even if it is true that private storage is reduced when no set-asides are used. The welfa economics of program alternatives are discussed below.)

Finally, it should be mentioned that the FOR program has been operated with a ceiling on the quantity of FOR grain, most explicitly for wheat, where a 700 million bushel maximum is specified in the Food and Agriculture Act of 1977. Such a ceiling is counterproductive in discouraging storage at the margin. Indeed, for wheat the ceiling was below the quantities that would most likely have been held anyway, although FOR quantities have never yet reached the 700 million bushel level.

In short, consideration of the constraints and incentives of the FOR program indicates that we should not be surprised at the finding that our most optimistic estimates of the FOR's effects on total grain stocks are 1 bushel in added stocks for each 4 in the program. The effect of the program is mainly to have grain that would have been held in private stocks or delivered to CCC switched instead to FOR stocks. There is an effect at the margin in increasing total stocks, but it is relatively small.

SECTION 5

FOR's EFFECT ON GRAIN PRICES

This section contains evidence on price effects of the
FOR during its first 3 years, using quarterly regression
analysis of farm prices. The estimated price effects are
quite small, in many cases zero. However, problems in
correct econometric specification exist even beyond those
in the preceding section. Indirect estimates of price
effects, based on FOR's stock effects converted to price
effects via demand elasticities, suggest a maximum price
increase of 4 percent due to the FOR in the 1977 and
1978 crop years.

If adding 400 million bushels to the FOR results in an
addition of 100 million bushels to total stocks, then 100
million bushels less must have gone into consumption and
export channels. Because of this change, market prices
should have been increased by FOR accumulation. Once the
stocks are accumulated, they are part of the available
supply and should have no direct price-supporting effects
in subsequent years. However, with lagged adjustment and
reaction in related sectors, notably the livestock industry,
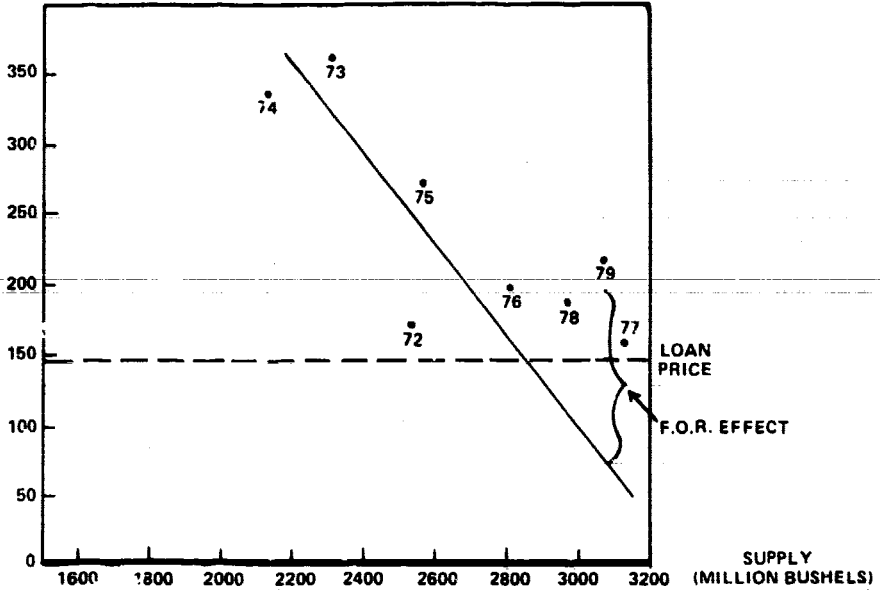the effects will show a more complicated time pattern.

To analyze the actual effects of the FOR program on
grain prices, we need a model essentially like the ones used
to explain ending stocks. Indeed, ending stocks and prices
are both endogenous variables in the same simultaneous
system used in the regressions of table 3.

Figures 2 and 2A show relationships between supply and
price (top panels) for wheat and corn. These are primitive
reduced-form equations in the same sense as the Gustafsonian
storage functions plotted in figures 1 and 1A. The lower
panels of figures 2 and 2A plot price against quantity of
carryover stocks. This is a structural relationship between
the two endogenous variables that the other diagrams plot
against supply. This structural relationship is the
reservation demand functions for ending stocks. In general,
such a two-dimensional plot of endogenous variables can be
seriously misleading. In the present case, any change in
the supply functions of storage (for example, a change in
storage capacity or real interest rates) would shift the
function, so would a shift in the demand function for
domestic use or exports of grain. Despite these limitations,
before moving on to the more nearly complete multiple-regression
specification, it may be worth noting what the simple two-way
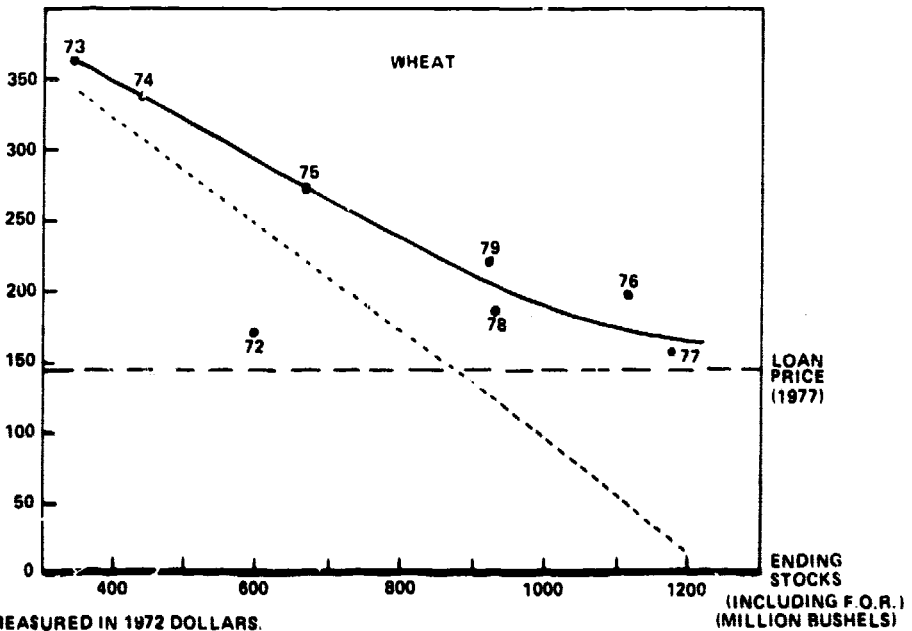plots suggest about FOR effects on grain prices.

FIGURE 2

FARM PRICE OF WHEAT AS RELATED TO SUPPLY AND STOCKS

a] MEASURED IN 1972 DOLLARS.

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FIGURE 2A

FARM PRICE OF CORN AS RELATED TO SUPPLY AND STOCKS

PRICE (NOTE a)
(CENTS PER BUSHEL)

SUPPLY
(MILLION BUSHELS)

LOAN
PRICE

PRICE (NOTE a)
(CENTS PER BUSHEL)

LOAN
PRICE
(1977)
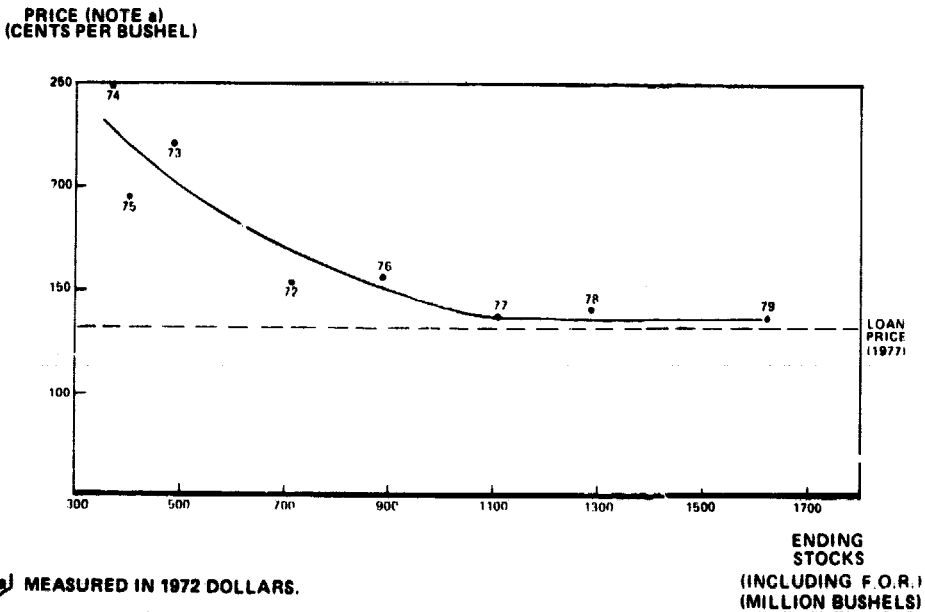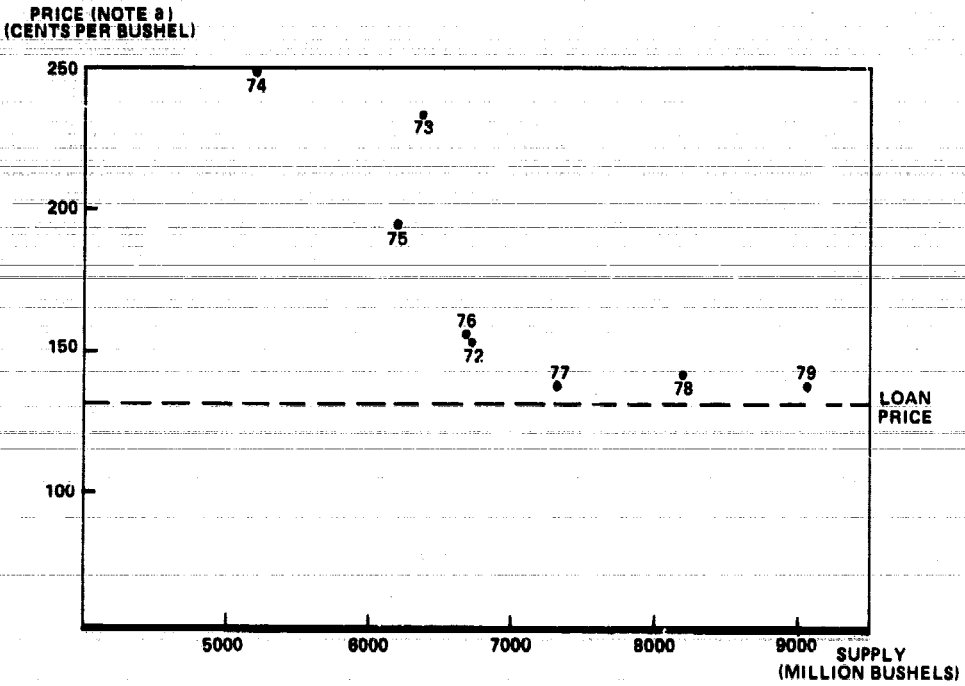
ENDING
STOCKS
(INCLUDING F.O.R.)
(MILLION BUSHELS)

a) MEASURED IN 1972 DOLLARS.

For wheat, fitting a least-squares line through the pre-FOR (1972-76) observations would indicate an FOR effect of the magnitude shown in figure 2. But clearly price would not have fallen to 50 cents per bushel in the 1977-78 crop year. The correct relationship must be nonlinear. If this were not true for the behavior of private stocks, nonlinearity would be forced by the operation of CCC's loan program. If we ask what the FOR program has done that would not already have been accomplished by CCC's loan program, the apparent FOR effects are much smaller.

In a regression model estimation of nonlinear functions can become complicated, but for present purposes the following simple approach should be adequate. Starting from a log-linear relationship,

$$\ln P = a + b \ln S$$

between supply (S) and price (P), incorporate the idea that b changes with S as a simple linear relationship,

$$b = \alpha + \beta S.$$

Substituting b into the lnP equation,

$$\ln P = a + \alpha \ln S + \beta S \ln S.$$

Thus, we can estimate a linear regression of lnP on lnS and S x lnS to obtain the nonlinear functional form of interest.

Table 4 shows three alternative functional forms for explaining wheat prices in annual data. Regression 13 is arithmetic. The coefficient of -0.32 on S means that a million-bushel increase in supply reduces price by 0.32 cents. In terms of more significant quantities, a 100-million bushel increase in supply reduces price by 32 cents per bushel. 1/ At a mean beginning supply value of 2.4 million

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1/The prices are USDA's estimates of season-average price received by farmers. The prices are deflated by the implicit gross national product (GNP) deflator (1972=100) so that all values are in 1972 dollars. Deflated prices were used because the general price level more than tripled over the 1950-80 period, the GNP deflator rising from 53.6 in 1950 to 170.7 in 1979:IV. Consequently, a $3.60 per bushel price of wheat, for example, has a quite different meaning in real terms today than it did 30 years ago. Since stocks management, production, exports, and other variables in the model are determinants of real prices, i.e., prices of grains relative to other goods, deflated prices are appropriate for present purposes.

Table 4

Regression Coefficients (with t ratios) Explaining
Prices Received by Farmers, using 2SLS Models

Equation (note a)	Supply (S)	S x lnS	Exports (E)	Program variables		
				IFOR	FOR	CCC stocks
(Annual data: 1950-1979)						
13. Wheat	−0.32 (3.4)		0.36 (2.8)		125 (2.2)	0.25 (3.8)
14. Wheat (logarithmic)	−2.5 (1.8)		0.62 (1.3)		0.54 (1.5)	0.89 (2.0)
15. Wheat (logarithmic)	−8.6 (1.2)	0.30 (0.9)	0.67 (1.4)		0.30 (0.6)	0.88 (2.0)
16. Wheat (logarithmic)	−2.5 (1.8)			2.0 (1.5)		0.82 (2.0)
17a. Corn	−0.5 (2.5)		0.17 (0.9)		−15 (0.3)	−0.02 (0.5)
17b. Corn (logarithmic)	−5.4 (1.5)	0.07 (1.3)	0.33 (0.9)		−0.24 (0.8)	0.16 (0.5)
(Quarterly data, 1973:IV to 1980:I)						
18. Wheat	−0.21 (8.3)		0.34 (2.4)		0.17 (0.7)	
19. Wheat (logarithmic)	−10.6 (1.9)	1.06 (1.8)	0.45 (2.4)	−0.12 (1.6)		
20. Corn	−0.05 (4.0)		−0.08 (1.4)	0.07 (2.2)		
21. Corn (logarithmic)	−7.9 (1.6)	0.77 (1.5)	0.75 (1.2)	0.06 (0.3)		
21a. Corn (log-kinked)	−3.3 (1.8)	0.02 (0.7)	0.45 (0.6)		5.0 (0.7)	

a/The equations also contain quarterly dummies for the interest intercept and for supply whose coefficients are not shown.

bushels and mean price of $2.70 (1972 dollars), the implied elasticity of total demand for wheat is -0.36.

Regressions 14 to 16 use nonlinear functional forms. The dependent variable is the natural logarithm of price, and supply and exports are also converted to logarithms. The coefficient of supply can now be read directly in percentage change (elasticity) terms. Thus, the coefficient of S of -2.5 in regression 16 implies an elasticity of total demand of -0.4. The supply effect is more difficult to interpret in regression 15 because of the cross-product term S x lnS. The price flexibility coefficient at the mean now is -2.3, which implies an elasticity of total demand of -0.43.

The FOR's coefficient is sensitive to functional form, as the bottom panel of figure 2 suggests. The line drawn in shows price as a function of supply as in regression 13. The vertical distance between the mean of the three points "77," "78," and "79" and the line is an estimate of an FOR effect of the same sort reflected in the coefficient of 125 in regression 13; that is, an estimated FOR effect of over $1 per bushel. The estimated effect is undoubtedly a spurious artifact of the linear specification. Therefore, the nonsignificant FOR effects estimated in the nonlinear regressions are probably better indicators of the actual state of affairs. In contrast to the nonsignificant FOR effects, CCC stocks appear to have had a significant price-supporting effect in wheat, as would be expected for data including the 1950s and 1960s. Indeed, the main problem with the annual regressions is that data is dominated by the earlier years and contain only 3 years under the FOR system.

Consequently, regressions 18 to 21 turn to quarterly data for the period since 1973. The FOR variables in these regressions indicate a significant price-increasing effect for corn in a linear regression (20). The IFOR coefficient of 0.07 in equation 20 says that each 100 million bushels added to FOR stocks increases price by 7 cents per bushel. Thus, the accumulation of about 250 million bushels of corn in each of the first 2 years of the FOR program should have increased price by about 20 cents per bushel over its level in the absence of the program in both the 1977 and 1978 crop years. However, the positive effect disappears in a nonlinear specification, as it did in the annual data.

The bottom panel of figure 2A suggests a more extreme nonlinear form than the logarithmic and log-interaction model that assumes the elasticity of total demand increases linearly with supply, as specified in the earlier equation $b = \alpha + \beta S$. The corn data, especially if the 1979 data-point projection is correct, suggests that b becomes essentially

zero at large supplies. This is a situation in which the
total elasticity of demand approaches infinity. This idea
can be incorporated into the econometric model by allowing
a kink to exist in the supply-price relationship. Some
coefficients from such a specification are shown in regres-
sion 21a. For present purposes, the noteworthy result is
that the estimated FOR effect is zero.

Besides the regression results reported in table 4, a
great many other specifications were tried. Some involved
alternative nonlinear functional forms. Others tried dif-
ferent time periods, using quarterly data as far back as
1950. Others involved adding independent variables, such as
support price (CCC's loan rate), the level of CCC stocks,
and time trends. Separate dummy variables were introduced
for quarters when wheat or corn were in release status.
Generally, while the supply and export variables had the
expected signs, the magnitudes of the coefficients were not
very stable, suggesting that we do not have a price-
explaining equation for either wheat or corn that one can
be very confident about.

The conclusions about price effects are consistent with
the earlier finding that the FOR program's likely effect on
stocks was small. If the program had only a small effect on
quantities moving into consumption channels, it could have
had only a small effect on price. The largest price effects
that could be made consistent with the evidence on stock
effects of the FOR is derived as follows. The FOR in its
first 2 years accumulated grain at a rate of about 500 mil-
lion bushels of grain per year. Using the estimates from
the annual data, this could have increased total stock ac-
cumulation by 125 million bushels each year.

The price effect of taking this quantity out of the dis-
appearance stream depends on the aggregate elasticity of
demand for U.S. grains. The lowest plausible value for this
elasticity, which gives the highest plausible price effects,
is about -0.25. 1/ This implies that each 1-percent reduction

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1/For evidence and discussion, see B. Gardner, "Optimal
   Stockpiling of Grain," Lexington Books, 1979, pp. 123-124.
   Recent work in USDA suggests an elasticity of demand for
   corn in the neighborhood of -1/4 and an elasticity of demand
   for wheat not far from -1, with cross-elasticities low enough
   to rule out an aggregate elasticity of demand for grain of
   less than -0.25. See H.S. Baumes and W.H. Meyers, "The Crops
   Model: Structural Equations, Definitions, and Selected
   Impact Multipliers," USDA-ESCS, NED Staff Report, March 1980.

in disappearance increases price 4 percent. Since 125 million bushels is about 1 percent of annual disappearance of grain, the implied price effect is about 4 percent. That is, the FOR may have increased grain prices in the 1977 and 1978 crop years 4 percent above their prices if there had been no FOR.

Even though the directly estimated FOR effects on prices are not statistically significant according to classical hypothesis testing, one's (Bayesian) prior beliefs may be strong enough to maintain an estimated price effect in the 4-percent area. But little basis exists in the evidence for a larger effect. The 4-percent increase in corn and wheat prices amounts to about $1 billion in increased market receipts to grain producers, and in this sense is not a trivial sum. (Net gains to producers were not this large, because if prices had been lower deficiency payments would have been higher.)

It is unfortunate but unavoidable that FOR effects on prices and stocks cannot be estimated more precisely. Because of the difficulties in obtaining sharp and robust parameter estimates in the models used in this paper, it is worth comparing other econometric studies. However, not many estimate the relationship between public stocks and prices and allow private stocks to respond to changes in public stocks.

Sharples and Holland 1/ fit a supply-of-storage model to wheat and estimate that each bushel in the FOR adds 0.4 to 0.87 bushel to total stocks. Baumes and Meyers 2/ have a more complete econometric model in which a bushel of corn in CCC stocks adds 0.24 bushel and a bushel of wheat in the FOR adds 0.44 bushel to total stocks. However, their model is estimated on data that end in 1976. Their main public-stock effects therefore reflect CCC stocks, which in my regressions above show larger effects than FOR stocks. Consequently the Baumes and Meyers estimates probably overstate the FOR effects they would find if they extended their model to later data. The Sharples and Holland estimates are based on 1977 and 1978 crop year data, and extensions to 1979 and 1980 prospective data seem to fit the supply-of-storage model less well.

1/J.A. Sharples and F. Holland, "Impact of Farmer-Owned Wheat Reserve on Total Wheat Stocks and Price," USDA-ESCS, IED Staff Report, April 1980.

2/H.S. Baumes and W.H. Meyers, op. cit.

A model of the feed/livestock sector by Arzac and
Wilkinson 1/ can be used to estimate public-stock effects for
corn in a model more complete than any other considered thus
far. However, their model does not have a fully satisfactory
equation for explaining private stocks and is estimated with
data that ends in 1975. Arzac and Wilkinson find that a bushel
of corn added to Government stocks has 23.6 percent of the
effect on the price of corn that a 1-bushel temporary surge
in exports would have. This is equivalent to an estimate that
a bushel added to Government stocks removes only 0.236 bushel
from consumption channels to total stocks.

In general, these studies are consistent with the small
FOR effects estimated above. However, each approach has serious
weaknesses. The fact that the attempts in this section and the
preceding one could find only weak and varying FOR effects seems
inescapably a true indicator that the FOR effects were
indeed weak. My provisional conclusion, until more evidence is
analyzed, is that one must be optimistic to attribute to
the FOR as much as 1 bushel in added total stocks for each 4
bushels of corn or wheat put in the program. Correspondingly,
modest price effects also seem inescapable.

1/E.R. Arzac and M. Wilkinson, "A Quarterly Econometric Model
   of U.S. Livestock and Feed Grain Markets and Some of Its
   Policy Implications," American Journal of Agricultural
   Economics, Vol. 61, May 1979, pp. 297-308.

SECTION 6

FOR's EFFECT ON PRICE STABILITY

In supporting farm prices in times of abundance, the FOR program transfers income from grain users to grain producers. The potential benefit to the country as a whole stems not from such transfers but from promoting greater price stability, which involves holding down price increases as well as supporting low prices. The only quarterly data that reflects attempts to hold prices down by releasing stocks are from the last half of 1979. However, the dummy for re- lease actions in the regressions of the preceding section was not able to capture any such effect in the quarterly data. This section explores two approaches to estimating the FOR's price-stabilization effects. First, in the quar- terly data, the linkages between the FOR program and stock- holding behavior can be considered further. Second, the behavior of shorter term (weekly or daily) price fluctuations can be examined. In neither case does there appear to be any significant stabilizing effects of the FOR.

ANALYSIS OF QUARTERLY DATA

While table 3 regressions did not show significant increases in quantities held in stocks due to the FOR pro- gram, it is possible that the program could have promoted price stability by means not captured in the regressions on stock levels. One way in which stability could be pro- moted is by increasing the marginal propensity of farmers to store increased supplies and to remove grain from storage when supplies are short. In terms of the regressions esti- mated earlier, the program could promote stability by in- creasing the coefficients of S in table 3. A statistical test for such an increase is to introduce an interaction term, FOR*S, whose coefficient measures the difference in the S coefficient resulting from FOR = 1 instead of zero. Such equations on 1972-79 quarterly data are shown in table 5.

The positive coefficient on FOR*S in regressions 24 and 25 indicates that corn stocks were more responsive to supply changes in the FOR quarters than before the program was established. However, the effect is not large and a null hypothesis that it is zero cannot be rejected at the 10-percent confidence level. Moreover, the negative sign of FOR*S in the wheat equations indicates that stocks were less responsive to supply in the FOR period, although the effect is not statistically significant. Thus, these regressions do not support the idea that the FOR program has had a significant stabilizing effect.

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Table 5

Regression Coefficients (with t ratios)
Explaining Quarterly Ending Stocks, 1972:III to 1980:I

Equation (note a)	Supply (S)	Exports (E)	FOR variables		
			IFOR	FOR	FOR*S
22. Wheat(2SLS)	0.98 (32.5)	−0.94 (6.0)		11 (0.2)	−0.014 (0.7)
23. Wheat(2SLS)	0.98 (33.3)	−0.96 (5.9)	0.035 (0.4)		−0.012 (1.0)
24. Corn(2SLS)	0.82 (18.2)	−0.60 (2.2)		−75 (0.5)	0.028 (1.2)
25. Corn(2SLS)	0.82 (17.5)	−0.71 (2.9)	0.077 (0.4)		0.013 (0.8)

a/Coefficients of intercept and quarterly dummy variables not
 shown.

The supply-FOR interaction term can also be used to
investigate further the price effects of the FOR program.
If the FOR program is stabilizing, price should change less
when supply changes under the FOR. This means that FOR*S
should have a positive sign (making the S effect less
negative). Regression results are shown in table 6. The
coefficient of FOR*S is indeed positive, although not
statistically significant for wheat. The point estimates
suggest that the elasticities of total demand for wheat
and corn are increased by about 12 percent for wheat (e.g.,
from −0.55 to −0.62) and by about 20 percent for corn (e.g.,
from −0.35 to −0.42).

Table 6

Regression Coefficients (with t ratios) Explaining
Quarterly Prices Received by Farmers, 1972:III to 1980:I

Equation (note a)	Supply (S)	Exports (E)	FOR variables		
			IFOR	FOR	FOR*S
Wheat	−0.24 (3.6)	0.15 (1.0)		−31 (0.3)	0.029 (0.7)
Wheat	−0.24 (3.6)	0.18 (1.2)	−0.07 (0.8)		0.023 (1.5)
Corn	−0.07 (5.7)	0.02 (0.2)		−31 (0.8)	0.014 (1.9)

a/Coefficients of intercept and quarterly dummy variables not
shown.

ANALYSIS OF DAILY DATA

More detailed evidence on grain price behavior under the
FOR program can be obtained by examining daily price data.
The data for cash corn and wheat at Chicago is shown in
figures 3 and 4. Two questions will be considered: first,
is the short-term behavior of prices or price variability
different following the introduction of the FOR program; and
second, what price effects have resulted from policy adjust-
ments during the FOR period?

A definitive answer to both questions requires knowing
what the time series of prices since mid-1977 would have
looked like if the FOR program had not been implemented.
Since we cannot obtain this knowledge by observation, it is
necessary to make indirect inferences. One approach is to
consider price variability before and after the FOR program.

Figure 5 shows the same daily prices as figure 3, but
plotted as two frequency distributions. The frequency
distributions show how often corn and wheat prices fell in
each of several price ranges. For example, the dotted curve
has a frequency of 0.11 at $2.60, which means that during
January 1975 to March 1977, 11 percent of the daily prices
were in the $2.60 range ($2.60 through $2.69). The dotted
distribution shows the price distribution of the 565 days
preceding the initial FOR policy moves; that is, the period
January 1, 1975, to the end of March 1977. The second
frequency distribution shows prices in the 560-day period from

FIGURE 3

DAILY AND 5-DAY MOVING AVERAGE PRICE OF WHEAT, CHICAGO CASH (NOTE a)
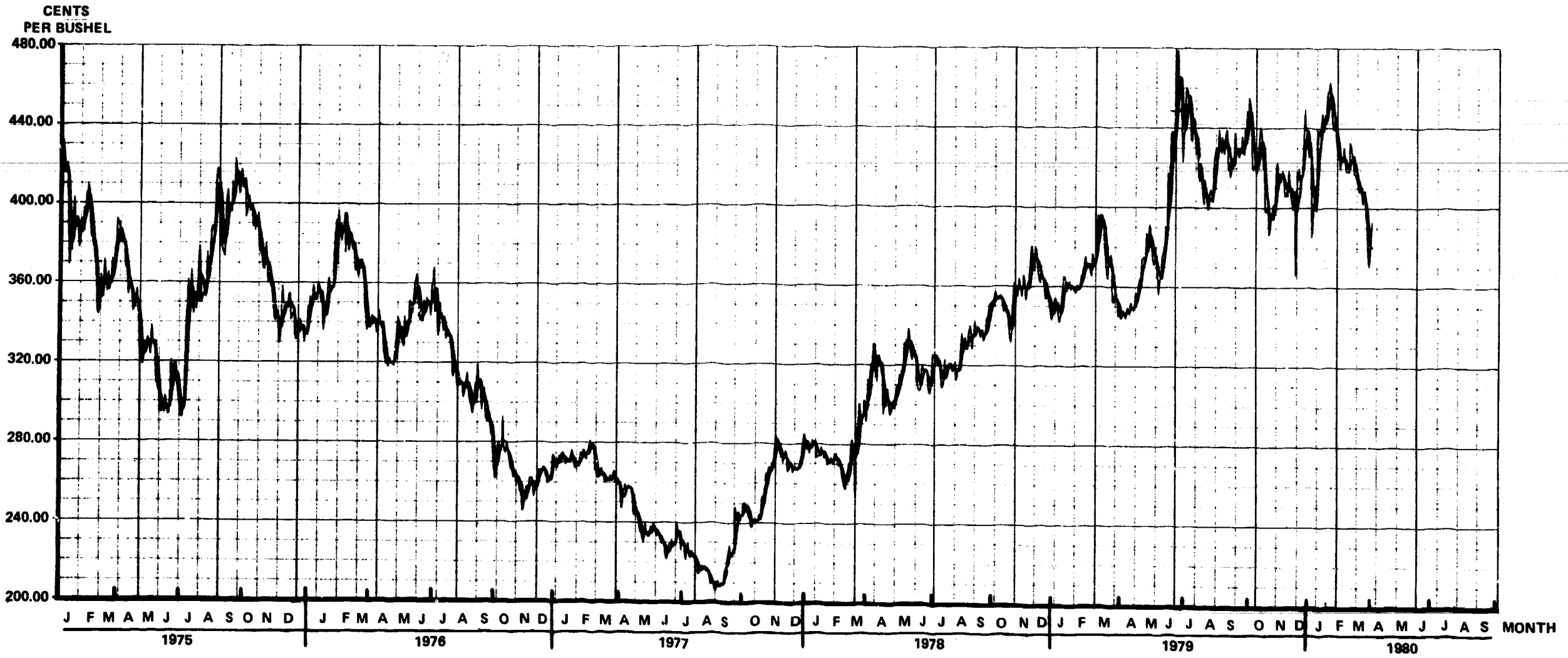
a) Simple average of price quotations for hard and soft wheat, as reported in Chicago Board of Trade's "Annual Statistical Report."

FIGURE 4
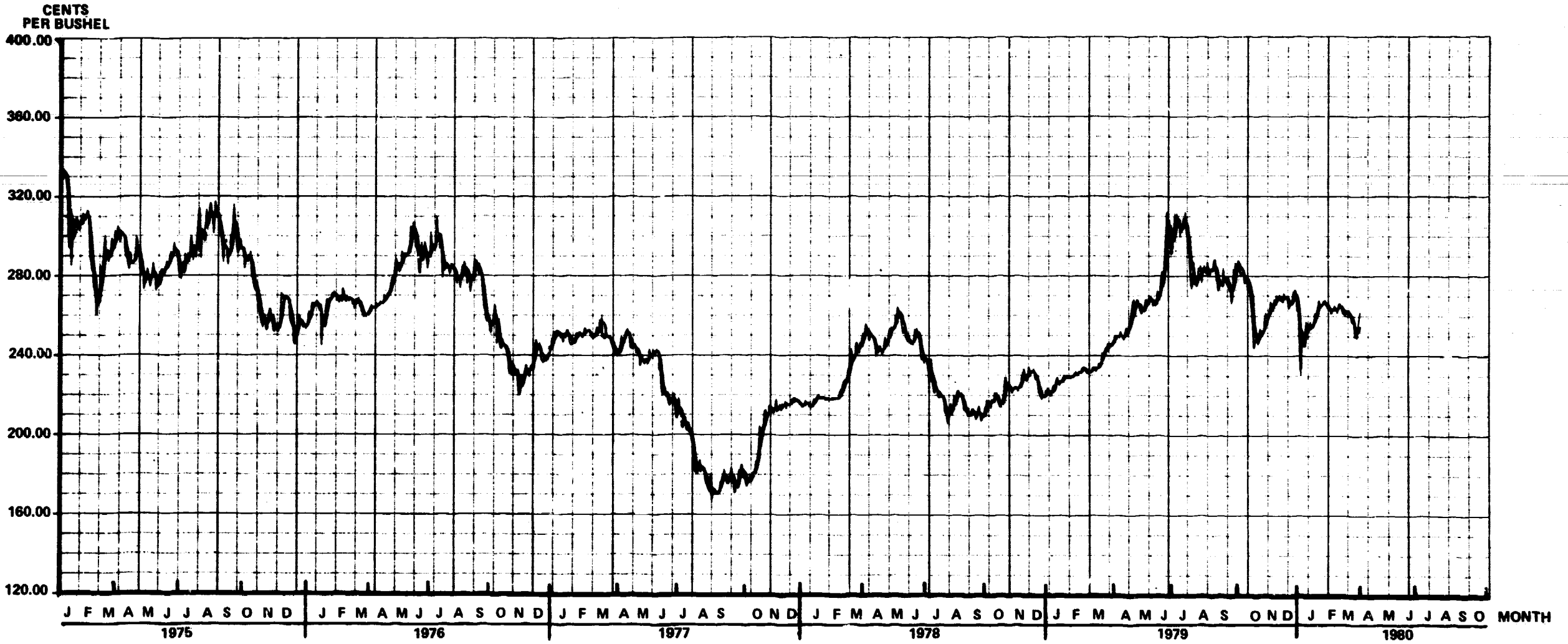
DAILY AND 5-DAY MOVING AVERAGE PRICE OF CORN, CHICAGO CASH

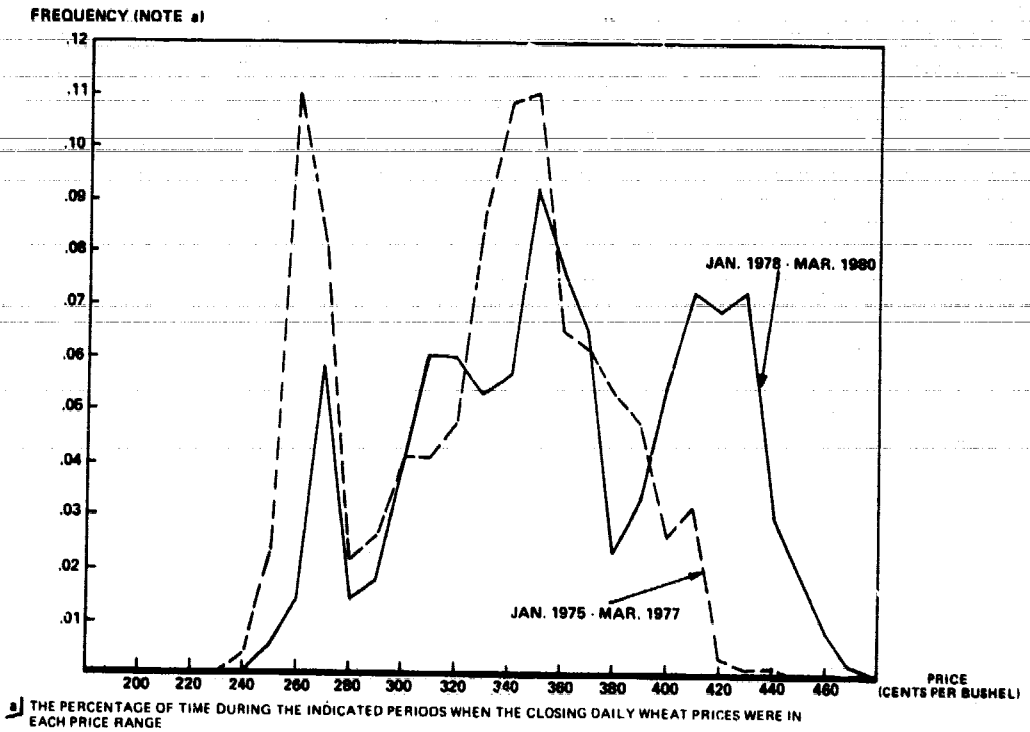FIGURE 5

WHEAT: DAILY CHICAGO PRICE

FREQUENCY (NOTE a)

JAN. 1978 - MAR. 1980

JAN. 1975 - MAR. 1977

PRICE (CENTS PER BUSHEL)

a] THE PERCENTAGE OF TIME DURING THE INDICATED PERIODS WHEN THE CLOSING DAILY WHEAT PRICES WERE IN EACH PRICE RANGE

January 1, 1978, to the end of March 1980, representing the
FOR period. The price data between April 1, 1977, and the
end of December 1977 are not included in either frequency
distribution. This is the period in which (1) the Govern-
ment was deciding on specific FOR provisions as well as
set-asides and other programs in the Food and Agriculture
Act of 1977, (2) the markets were adapting to this informa-
tion, and (3) the wheat price bottomed out from a 2-year
period of decline and began a 2-year period of increase.

The variability of price is revealed by the shape of the
frequency distribution. A constant price would show a spike
with frequency 1.0 at that price and 0.0 at all other prices.
The greater the variability of prices, the more the frequency
distribution is spread out or dispersed--the greater the
frequency of prices far from mean price. The dispersion
of the FOR and pre-FOR price distributions in fact seems quite
similar, although the FOR period covers a slightly wider price
range.

In order to be more precise about comparisons of price
variability, a summary statistic for each distribution is
necessary. The most common measure of variability is the
standard deviation. The standard deviations of the two
wheat price distributions of figure 5, as well as statistics
for other price distributions discussed below, are shown in
table 7. The standard deviation of the wheat price is
slightly greater in the FOR period.

These standard deviations do not necessarily imply that
the FOR program has been destabilizing. For one thing, the
mean price of wheat was 32 cents per bushel higher in the
FOR period (although the FOR-period mean is lower in real--
deflated--dollars), so that in relative terms the standard
deviation may be misleading. A measure of relative price
variation is the coefficient of variation--the standard
deviation divided by the mean. As table 7 shows, the co-
efficient of variation is also greater in the FOR period.
A second and perhaps more significant reason why this
comparison does not necessarily imply that the FOR was not
stabilizing is that there may have been more underlying
market instability in the FOR period, so that in the
absence of the FOR program, the comparison would have been
even more unfavorable to the 1978-80 period. This issue
will be discussed further.

The frequency distribution of wheat prices suggests
that the FOR has some effects beyond overall stabilization.
One expects price distributions to be unimodal; that is, to
have single peak frequency in the neighborhood of mean price,
unless strong cyclical or trend components are present. The

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Table 7

Indicators of Variation of Daily Grain Prices

Crop and period	Mean	Standard deviation	Coefficient of variation
	(cents per bushel)		
Wheat, Jan. 1975 to March 1977	334	46.1	13.8
Wheat, Jan. 1978 to March 1980	366	52.3	14.3
Corn, Jan. 1975 to March 1977	274	22.8	8.3
Corn, Jan. 1978 to March 1980	247	24.9	10.1
Soybeans, Jan. 1975 to March 1977	583	97.5	16.7
Soybeans, Jan. 1978 to March 1980	672	54.6	8.1

high frequencies of relatively low prices, in the $2.50 to
$2.80 range, are attributable to the existence of a market
support price established by CCC's loan program. It existed
in both the FOR and pre-FOR periods. The new element in the
FOR period is the release price, which is to encourage hold-
ing stocks until price reaches the release trigger ($3.15 or
$3.29 during most of this period). This element suggests
that price ought to move more readily up to the release level
under the FOR, and indeed the FOR-period frequency distribu-
tion does show a peak at higher prices that does not exist
in the pre-FOR price distribution.

The relationship between FOR release prices and the
market price distribution can be seen in figure 6, which
shows the frequency distribution of the wheat price
actually used in making FOR release decisions. This price
is a 5-day moving average of cash prices at principal
markets, adjusted monthly to place it at a U.S. average
farm basis. This price is not available for the pre-FOR
period and is therefore shown only for the January 1978 to
March 1980 period. Note that the frequency of prices in the
neighborhood of the release price is very low, with high
frequencies between the release and call levels.

Turning to daily corn prices, the distributions of
price as plotted in figure 7 look roughly similar in dis-
persion in the FOR and pre-FOR periods, although mean price
is clearly higher in the pre-FOR period. The standard
deviation and coefficient of variation of the daily corn
price is slightly greater during the FOR period, as was the
case for wheat.

Another way of looking at the variability of daily
prices is to consider the sequence of daily price changes.
These can tell a quite different story when the underlying
mean price is changing over time. The frequency distribu-
tions of daily changes in the natural log of price, which
measure percentage changes, are shown in figures 8 and 9
for wheat and corn. Here the higher frequencies of small
changes indicate more stability in the FOR period, although
the difference in the standard deviation of daily price
changes is small--only a few tenths of 1 cent.

A final comparison considers the standard deviation
of price around regressions of daily prices on trend.
Linear and quadratic trends were tried. In either case,
the standard deviations of the residuals were lower in the
FOR period for wheat, but essentially the same in the FOR
and pre-FOR periods for corn.

FIGURE 6

WHEAT: ASCS 5 - DAY MOVING AVERAGE PRICE, JAN. 1978-MAR. 1980, ADJUSTED TO FARM LEVEL
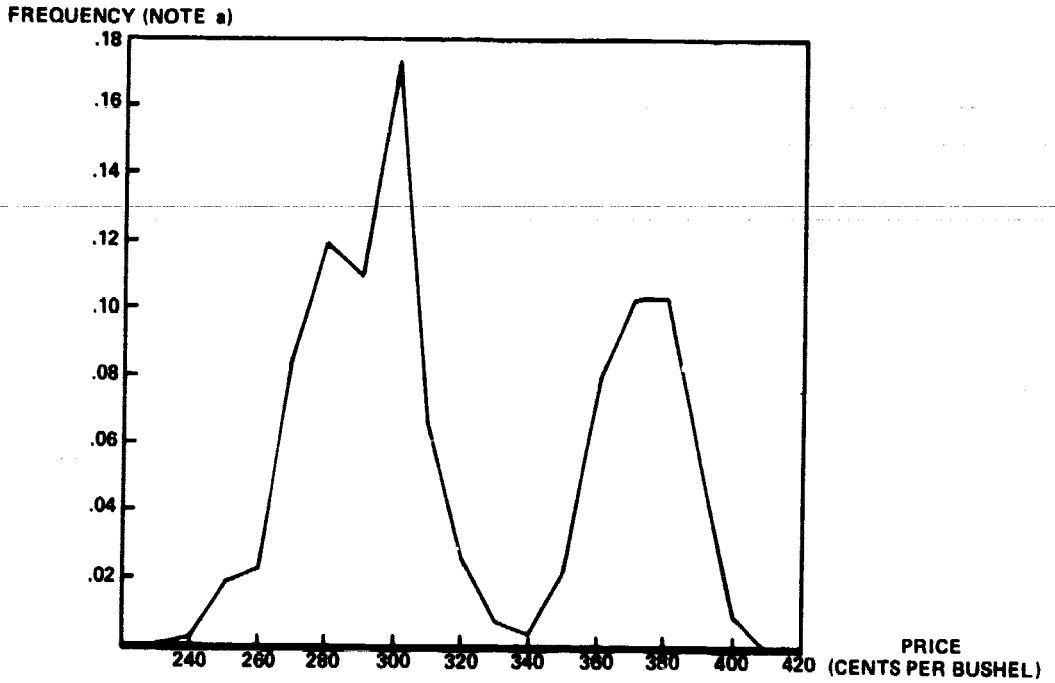
FREQUENCY (NOTE a)

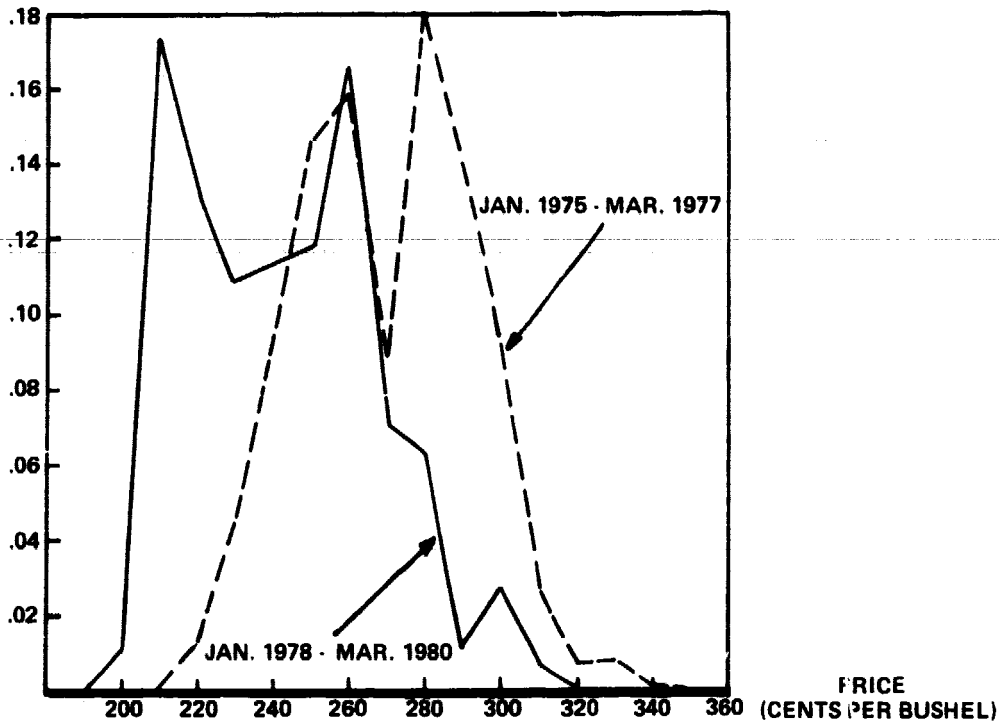a) THE PERCENTAGE OF TIME DURING THE JAN. 1978-MAR. 1980 PERIOD WHEN THE 5—DAY MOVING AVERAGE WHEAT PRICE WAS IN EACH 10-CENT PRICE RANGE.

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FIGURE 7

CORN: DAILY CHICAGO PRICE

FREQUENCY (NOTE a)

JAN. 1975 - MAR. 1977

JAN. 1978 - MAR. 1980

PRICE
(CENTS PER BUSHEL)
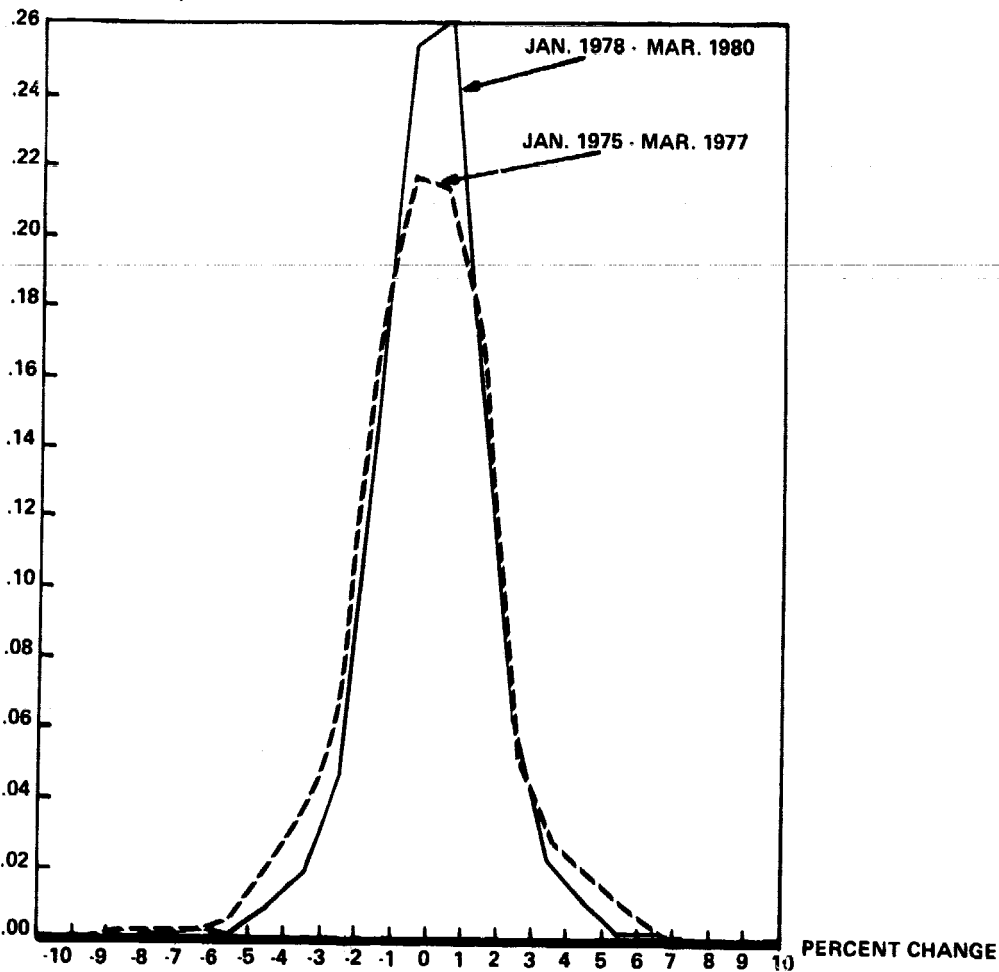
a) THE PERCENTAGE OF TIME DURING THE INDICATED PERIODS WHEN THE CLOSING
DAILY CORN PRICE WAS IN EACH 10-CENT PRICE RANGE.

FIGURE 8

WHEAT: DAILY PRICE CHANGES

a] THE PERCENTAGE OF TIME DURING THE INDICATED TIME PERIODS WHEN THE DAILY WHEAT PRICE CHANGE (EXPRESSED AS A PERCENTAGE) WAS AT EACH INDICATED "PERCENT CHANGE" LEVEL.

FIGURE 9

CORN: DAILY PRICE CHANGES

FREQUENCY (NOTE a)

FIGURE 9

CORN: DAILY PRICE CHANGES

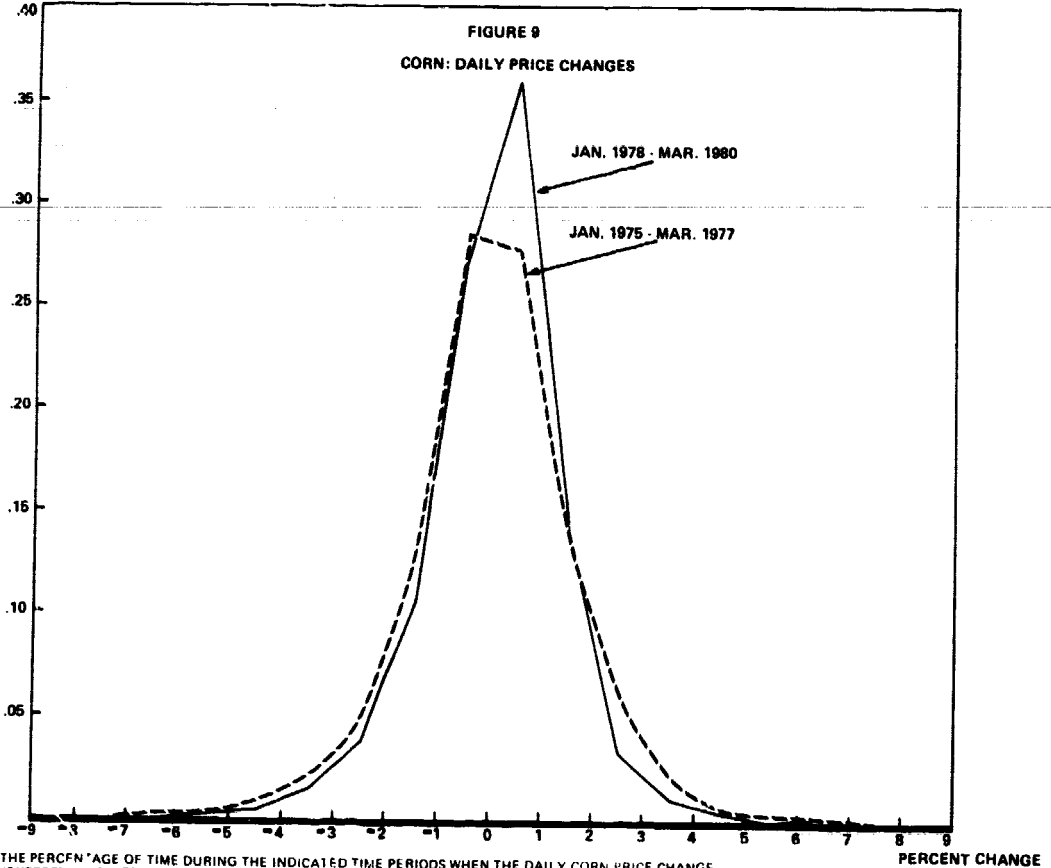JAN. 1978 - MAR. 1980

JAN. 1975 - MAR. 1977

PERCENT CHANGE

a] THE PERCENTAGE OF TIME DURING THE INDICATED TIME PERIODS WHEN THE DAILY CORN PRICE CHANGE
(EXPRESS   S A PERCENTAGE) WAS AT EACH INDICATED "PERCENT CHANGE" LEVEL.

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Barley is of special interest with respect to release and call because it has had call status (although the ostensible penalties for holding grain after the call price had been reached were never applied). The frequency distribution of barley prices (figure 10) shows the same bimodal distribution as wheat.

It could be that the absence of unimodal price distributions is primarily due to nonstationarity of the underlying mean price and not to the FOR program. However, the nonstationarity is not due to trends or cycles that standard techniques of statistical time series analysis can remove. A more likely possibility is one or two structural shifts in the perceived supply/demand situation during 1978-79. The most likely is the news of the Soviet grain production shortfall that affected the markets in June 1979. Other possible shifters of the supply/demand fundamentals include successively higher U.S. grain production estimates in 1979 and the announcement of set-aside decisions.

To sort out such influence from FOR program effects, the wheat and corn prices shown in figures 3 and 4 were used as dependent variables in a regression model. An econometric model of daily grain prices cannot be completely successful since we lack daily data on important explanatory variables. Daily price movements depend on changes in market participants' perceptions of supply/demand conditions, which we have no means of measuring. What we have are periodic crop estimates and announcements of officially measured rates of inflation, exports, and policy proposals. While treating these as exogenous variables will not explain many short-term price movements, we may be able to hold underlying economic conditions constant in order to isolate FOR program effects on the remaining residual price movements.

Results of regressions explaining daily wheat and corn prices between January 1, 1975, and March 31, 1980, are shown in table 8. The regressions are ordinary least squares. Attempts to use USDA crop estimates and export reports were unsuccessful, probably because the commodity markets anticipated this information and so had largely incorporated it in prices before the dates when the estimates were made public. The time series in figures 3 and 4 exhibit apparent short-term random variation around longer term price movements that do not appear to be cyclical. Wheat has an apparent U-shaped trend that could be approximated by a quadratic function of time. The daily price models estimated include quadratic trends, the gross national product deflator, two policy-determined prices (loan price and release price), and several dummies representing exogenous events and policy decisions.

FIGURE 10

BARLEY: DAILY MAJOR MARKET PRICES, 1978-80 (NOTE a)

FREQUENCY (NOTE b)

PRICE
(CENTS PER BUSHEL)
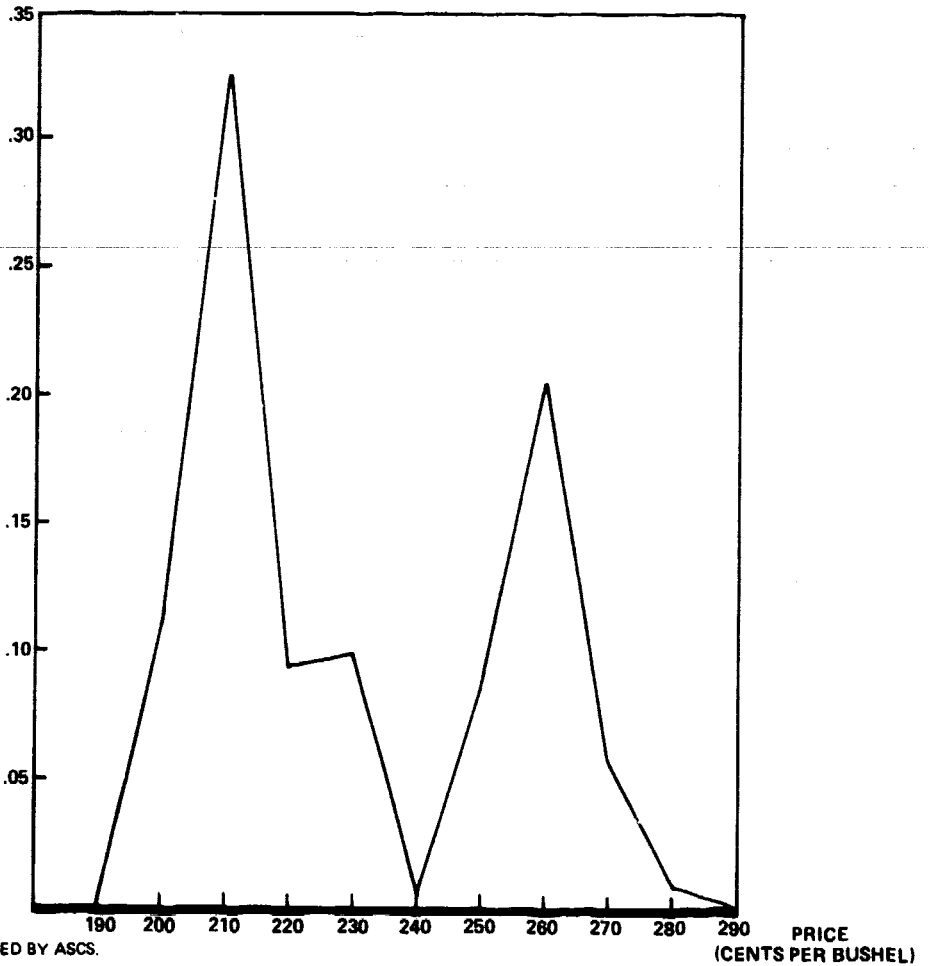
a] AS COMPUTED BY ASCS.

b] THE PERCENTAGE OF TIME DURING THE 1978-80 PERIOD WHEN THE AVERAGE DAILY MAJOR MARKET
BARLEY PRICE WAS IN EACH 10-CENT PRICE RANGE.

Table 8

Regressions Explaining Daily Corn and Wheat Prices, Jan. 1975 – March 1980: Coefficients (and t Values)

Independent variables	Wheat		Corn	
T: daily trend index	-9442. (24.0)	-4955. (14.2)	-496. (1.9)	-225. (25.6)
T	434. (23.0)	228. (13.3)	14.9 (1.2)	
PGNP: general price level	410. (7.4)	441. (7.2)	498. (45.8)	583. (23.7)
PS: loan rate	0.14 (2.6)	0.01 (0.1)	-0.37 (7.0)	-0.51 (9.9)
PR: release trigger price	0.06 (1.9)	-0.06 (1.7)		
FOR: dummy	-27. (8.5)	-55. (18.9)	-27. (9.6)	-24. (8.6)
Set-aside wheat	12. (3.5)	12. (3.0)		
Set-aside corn	29. (2.9)	31. (11.4)	38. (15.3)	39. (20.0)
AAM: dummy	25. (9.3)	25. (11.3)	-3. (1.3)	-1. (0.8)
SOV75: dummy	21. (7.9)	33. (11.9)	-0.4 (0.2)	3.1 (1.9)
EMB75: dummy	4. (1.1)	44. (13.2)	23. (7.6)	22. (8.8)
SOV79: dummy	26. (5.3)	49. (8.6)	35. (12.6)	40. (13.7)
EMB80: dummy	-18. (4.9)	-18. (4.5)	-11. (3.0)	-3. (0.9)
NOWHTSTO: dummy	-2. (0.4)	-4. (0.8)		

Independent variables	Wheat		Corn	
SOVDEAL: dummy	93. (19.8)		-61. (0.2)	
CARTER: dummy	-2.5 (0.8)		-19. (8.2)	
R^2	0.914	0.890	0.779	0.763

Table 9

Definitions of Variables

T is based on an index that increases by 1 for each daily price quotation. For better scaling, it starts at 10,000 and is divided by 1,000.

PGNP: The general price level is measured by the GNP deflator, 1972=100.

PS: The loan rate is the support price applicable to grain of the current marketing year under loan.

PR: The release price is the officially announced release price for all dates following the announcement of the program in April 1977. Prior to the FOR program, PR takes the value of 1.15 times the loan rate.

FOR: For wheat it is 1 after March 23, 1977, otherwise zero; for corn it is 1 after August 15, 1977.

Set-aside: For wheat, it is 1 between August 29, 1977, and August 15, 1979; for corn, it is 1 between November 15, 1977, and October 22, 1979.

AAM: It is 1 between March 29, 1978, and March 30, 1979.

SOV75: It is 1 between July 2, 1975, and June 30, 1976.

EMB75: It is 1 between August 11, 1975, and October 20, 1975.

SOV79: It is 1 after June 6, 1979.

EMB80: It is 1 after January 6, 1980.

NOWHTSTO: It is 1 during the period in which no storage payments were being made on wheat in release status under the FOR program, after June 30, 1979.

SOVDEAL: It is 1 after October 20, 1975.

CARTER: It is 1 after November 4, 1976.

TABLE 10

Policy Decisions and Events Affecting The Wheat and Corn Markets

March 24, 1977	In congressional testimony, wheat FOR program intentions announced.
April 1, 1977	Announcement of Farmer-Owned Reserve program details for wheat and rice. Interest rate on CCC loans cut from 7.5 to 6 percent. Loan rate for 1977 crop corn increased to $1.75 from $1.50 per bushel.
August 29, 1977	Target of 17 to 19 million tons in feed grains FOR announced.
August 29, 1977	Intentions for 20-percent set-aside on 1978 wheat announced.
September 29, 1977	Food and Agriculture Act of 1977 becomes law. Statutory basis for FOR. Raises target prices and loan rates for wheat and corn.
November 18, 1977	Announcement of conditional 10-percent set-aside for 1978 feed grains (except oats).
February 8, 1978	FOR storage payments increased from 20 to 25 cents per bushel. Final set-aside announcement for feed grains.
March 29, 1978	USDA policy moves to counter American Agriculture Movement announced: wheat graze-out payments, voluntary diversion program for corn, waiver of interest on FOR loans after 1 year, ceiling on FOR quantities removed.
May 15, 1978	Emergency Agricultural Act of 1978 becomes law. Increased target price on wheat.
June 26, 1978	Wheat loan level raised from $2.25 to $2.35 per bushel, hence raising FOR release price from $3.15 to $3.29 per bushel. (Interest rate on CCC loans increased from 6 to 7 percent on June 13.)

July 20, 1978	Procedures for determining when market prices have reached release and call levels published.
August 15, 1978	Announcement of continuation of 20-percent set-aside for 1979 wheat.
November 1973	Announcement of set-asides for 1979 feed grains.
May 16, 1979	Wheat enters release status.
June 19, 1979	Corn enters release status.
June 30, 1979	Wheat FOR storage payments stopped.
August 1, 1979	Corn no longer in release status.
August 15, 1979	Announcement of no set-asides for 1980 wheat.
October 22, 1979	Announcement of no set-asides or diversion for 1980 feed grain crops.
October 3, 1979	Corn enters release status.
November 30, 1979	Corn no longer in release status.
January 4-8, 1980	Suspension of grain sales to Soviet Union announced. Markets closed for 2 days, during which Government announced intent to cushion market impact. Loan rate raised to $2.50 from $2.35 for wheat, and to $2.10 from $2.00 for corn. Release and call prices also raised. Interest on FOR loans suspended during first year of loan, and storage payment raised from 25 to 26.5 cents per bushel.
February 1980	Decision announced not to introduce voluntary diversion program for feed grains.

A list of variable definitions is given in table 9 and a brief chronology of events under the FOR is provided in table 10.

The regression model explains a surprisingly high percentage of the daily variation in price, as indicated by the R^2, ranging from 0.763 to 0.914. Nonetheless, one must be cautious in interpreting the regression coefficients because they may not be measuring exactly what the label says. For example, EMB75 shows the effect of being in the period August 11 to October 20, 1975, when the halt on U.S. grain sales to the Soviet Union was in effect. Presumably the higher price of wheat in this period (21 or 33 cents per bushel according to the coefficients) is attributable to some left-out factor. Other variables, such as EMB80, are ambiguous. EMB80 represents the period during which grain sales above the long-term agreement's guarantee were suspended. But it is also the period during which remedial policy steps to support U.S. prices were in effect. The negative coefficient suggests that these remedial efforts were insufficient to avoid a price decline resulting from the embargo. While in early January the estimated corn supply was revised upward unexpectedly, this does not seem to explain the negative EMB80 coefficient, since the effect is more negative for wheat than for corn.

The regression results suggest that the FOR program had no positive effects on the price of wheat or corn. The negative coefficient indicates that prices were lower after the FOR was introduced, other things held constant. However, this effect might be due in part to the quadratic trend which indicates a trend toward rising prices in the second half of the data period, especially for wheat. This rising trend could be due in part to the FOR. The possibility was tested by reestimating the equations without the trend variables. The FOR coefficients remained negative.

Figures 3 and 4 clearly indicate that grain prices began a 2-year period of generally rising trend soon after the FOR program was announced. This has been attributed to the FOR:

"The wheat and rice reserve strengthened prices as farmers began isolating substantial amounts of the abundant 1977 crop from the market. * * * Corn prices increased from $1.60 in September (1977) to $2.24 by April of 1978

in spite of the large harvests. Without the reserve, they would undoubtedly have been much lower." [1/]

The regression coefficients suggest, however, that the higher prices seem to be more particularly associated with set-asides than with the FOR program. Let us consider whether the behavior of the time series in figures 3 and 4 appears consistent with the hypothesis that grain price strength is more plausibly associated with set-asides than with the FOR. The FOR for wheat was announced at the end of March 1977. Although details of the program were unknown to market participants, anticipation of price support from the program should have encouraged wheat holders to refrain from selling to some extent, and hence should have supported prices immediately. Yet wheat prices continued to fall. The trough came in mid-August 1977. The turn-around occurred almost exactly (within a week) of the August 15 announcement of a set-aside program for 1978 wheat. The first significant accumulations of wheat in the FOR began in the end of 1977 and accelerated in the first quarter of 1978 (table 11).

A significant upward move in wheat prices occurred in March and April of 1978, which were in fact the months of largest accumulation of wheat in the FOR. However, at this same time USDA was announcing programs to respond to the demands of the American Agriculture Movement (AAM). The effect is reflected in the strongly positive AAM variable in the regressions. These policy moves involved a wheat grazing program and voluntary (paid) diversion of feed grain acreage, which could reasonably be expected to reduce production and hence increase prices. In summary, evidence in the daily data support the hypothesis that both FOR and other policy moves affected wheat prices, but the FOR does not appear as a dominant factor. The daily data does not conflict with the evidence from the quarterly regressions that FOR effects were relatively small.

The price of corn at Chicago ended its 1977 decline at about the same time as wheat but did not rise rapidly until November (figure 4). If this behavior is attributable to any policy move, it is most plausibly the announcement of feed grain set-asides, which were not announced in August, as wheat was. A provisional determination of feed grain set-asides for 1978 was announced November 15, 1977. As with wheat, the next major increase in corn prices occurred in March-April

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1/USDA press release. Statement by Howard Hjort, ESCS, USDA, before the Senate Committee on Agriculture, Nutrition, and Forestry, Nov. 27, 1979, p. 5.

1978. But the first significant accumulation of corn
in the FOR began in May 1978, at which time the corn price
peaked and indeed began to decline. In the first period of
large, sustained movement of corn into the FOR, the last 4
months of 1978, price rose slightly but remained low compared
with earlier in the year. The single largest monthly addition
to the corn FOR was 206 million bushels in December 1978
(table 11). The really substantial increases in the price
of corn did not begin until March 1979. Overall, no support
exists for the hypothesis that the FOR influenced the time
series of corn prices significantly.

TABLE 11

Monthly Accumulation of Wheat and Corn in the FOR, June 1977 Through January 1979

Month	Wheat		Corn	
	Level (note a)	Change	Level (note a)	Change
	------------(million bushels)------------			
June 1977	1	1	0	0
July	5	4	0	0
August	10	5	0	0
September	15	5	0	0
October	24	9	0	0
November	45	21	0	0
December	64	19	0	0
January 1978	84	20	0	0
February	101	17	2	2
March	201	100	5	3
April	277	77	8	3
May	317	40	57	49
June	342	25	97	40
July	364	22	120	23
August	370	6	163	43
September	382	12	234	71
October	388	6	305	71
November	394	6	423	118
December	400	6	629	206
January 1979	404	4	715	86

a/At end of month.

The price effects of Soviet grain shortfalls in 1975
and 1979 and consequent demand for U.S. imports provide an
opportunity to compare market response with a sudden change
in supply/demand prospects. Grain market participants

became aware of both shortfalls quite suddenly, and both were immediately perceived to have serious consequences. The Soviet production decline from the preceding year turned out to be of about the same magnitude in both cases—about 60 million metric tons. The percentage decline of about one-third was a little greater in 1975; and the decline was relatively more concentrated in coarse grains in 1975 and in wheat in 1979. The resulting increase in Soviet imports, however, was greater in 1975 for both wheat and corn. In summary, in each instance we observed a suddenly perceived shock of roughly equal magnitude. The difference is that in 1979 the FOR program was well established, but no such program existed in 1975. Did the FOR contribute noticeably to the market's ability to cope with events in 1979?

The regression results suggest not. The daily regression coefficients SOV75 and SOV79 in fact show a larger price impact in 1979 than in 1975 for both wheat and corn. The daily price data in raw form suggest a similar conclusion. In both 1975 and 1979 the price of wheat and corn rose about $1 per bushel and about 30 cents per bushel, respectively, in the month following perception of the shortfall in the markets. Moreover, subsequent short-term swings in price appear just as pronounced in 1979 as in 1975. At the U.S. farm level, the story is a little different in that monthly prices received by farmers rose somewhat less in 1979 than in 1975.

Another interesting parallel is that in both instances the U.S. Government intervened to halt the increased flow of U.S. grain to the Soviet Union. In 1975 sales were stopped after about 10 million metric tons of wheat and corn had been sold. In 1979-80 sales above 8 million metric tons were canceled at the beginning of 1980. It is questionable whether either embargo had much effect. The 1975 embargo lasted for only a little over 2 months. It was ended in October 1975 with the signing of the long-term grain trade agreement that governed the 8 million metric tons permitted in 1979. The regression coefficients EMB75 and EMB80 suggest a small negative effect on price in 1980 but a positive effect in 1975. The latter coefficient is not believable, but it is clear from the plotted daily prices that both wheat and corn prices held at near their peak levels throughout the 1975 embargo and only declined after the long-term agreement went into effect.

The finding that the grain markets were not more stable in 1979 than in 1975 is especially remarkable in that stocks were significantly greater in 1979 than in 1975. Wheat stocks at the end of the second quarter were 435 million bushels in

1975 and 925 million bushels in 1979. Corn stocks at these
same times were 1.5 billion bushels in 1975 and 3.2 billion
bushels in 1979, and in 1975 were on the way to the lowest
carryover since World War II. The existence of larger stocks
in 1979 should have moderated price movements in 1979 as com-
pared with 1975 even in the absence of an FOR program. This,
along with the data on daily prices presented earlier in
table 7, raises the question whether the FOR might actually
have been destabilizing. The fact that the standard devia-
tion of daily price changes is slightly larger in the FOR
period is not in itself good evidence that the FOR was de-
stabilizing, because it may have been operating in a funda-
mentally less stable period. However, the Soviet shortfall
discussion casts doubt on that excuse for the FOR. Also,
note that soybean prices, without the help of an FOR program,
were substantially more stable in the 1978-80 period than
in 1975-77 (table 7). While again this is not conclusive
evidence, it suggests that the market situation was not
inherently more unstable in the FOR period.

How could a program intended to promote price stability
generate instability? One possible reason is that program
provisions were changed so often, so unexpectedly, and with
sufficient magnitude as to be destabilizing despite inten-
tions to stabilize. The operational characteristics by which
the determination of release is linked to market prices have
emerged piecemeal and are not easily understandable. And
when storage payments have been stopped, or program changes
made, particular regional adjustments have been made that
magnify uncertainties in the regional allocation of grain.
More fundamentally, the program parameters themselves have
been changed in response to short-term events; for example,
the changes in storage payments, release prices, interest
charges, and program eligibility that were made in an
attempt to cushion the impact of the 1980 embargo. In sum-
mary the FOR program has not functioned as a stable and
reliable framework within which farmers may undertake
marketing and storage activities.

A second possible reason is the encouragement of
farmers to sell stocks at the release price, but not before.
It is not possible to test directly for the effects of
triggering the release mechanism in either the daily or
quarterly data. If one places a dummy variable for days or
quarters when release was in effect, the estimated effect
on price is positive. But this does not mean that release
caused high prices; it means that high prices trigger re-
lease. The level of the release price was included in the
daily wheat regressions, but its effect is ambiguous.

The most appropriate tests consider overall price fluctuations during the FOR period, as is done in table 7 and the discussion of the frequency distributions in figures 5 and 6. The wheat data suggest that price tends to rise more readily to the release level than would have been the case in the absence of the FOR. The reason is that even though holders of stocks would normally sell grain from stocks as soon as prices rose above mean price (because opportunities for speculative gains disappear), stockholders are penalized if they do so under the FOR. Thus, the demand for ending FOR stocks is quite inelastic up to the release price, and it takes only a relatively small change in expected supply or exports to push price up to the release level. 1/

This argument suggests that prices have been made slightly more unstable by the FOR because it has made prices more sensitive to supply/demand shifters at price levels below the release price. However, the program reduces the probability that prices will rise much above the release price and, even more so, the call price. The problem is that we have not observed in the FOR period the extreme shortage situations in which this sort of stabilization would be observed. 2/ In this sense, the FOR has not yet been given a full test and it is still too soon to judge its effectiveness at stabilization.

1/This point is well argued in the context of year-to-year carryover by Jerry Sharples, "An Alternative Farmer Reserve Program," USDA-ESCS, April 1979, pp. 5-7.

2/If the real stabilizing benefit of the FOR is that it makes less likely the exhaustion of speculative stocks and consequent extreme prices, as were observed in 1973-74, further questions can be raised about FOR performance to date. The wheat market has already been very close to (and the barley and oats markets exceeded) the call price triggers at which substantial incentives are brought to bear to encourage farmers to place FOR stocks on the market. Thus, if situations comparable to 1973-74 occurred again, the FOR appears too prone to leave us where we were then--out of stocks when we really need them.

PRICE STABILIZATION IN THE LONGER TERM:

WELFARE ANALYSIS

Apart from the short-term effects on price variability, the FOR program should moderate year-to-year variations in price by increasing the average size of carryover stocks. However, the earlier regression analysis of annual and quarterly stock data indicated that stocks have not been increased much by the program. Many of the regressions showed no significant effect at all. An optimistic overall assessment was that each 4 bushels placed in the FOR adds 1 bushel to total stocks.

Supposing that the FOR would be this effective, what long-term gains to the Nation may be expected? Let us suppose that over a period of years the mean size of the FOR stock will be 20 million metric tons (about 800 million bushels) of wheat and feed grains, and that the resulting increase in mean total stocks is 5 million metric tons (about 200 million bushels). 1/ In some years, of course, the FOR will have more grain while in others it will be depleted to cover shortages at the release or call price.

The amount by which the Nation would be better off from such an increase in stocks depends on the answers to two questions: How much are prices stabilized? How valuable is the degree of price stabilization attained? The answers to both questions involve analytical difficulties beyond those encountered so far in estimating effects of the FOR on stocks and prices.

The degree of price stability resulting from a given increase in mean stocks can only be estimated directly by observing year-to-year price variability over a substantial period of years. Estimates were developed of the potential price-stabilizing effects of the FOR as follows. First, a stochastic time series of annual prices was simulated under the assumption of rational profit-seeking private storage behavior under production and export variability of the magnitude experienced in recent years. This simulation yielded a price variance of $970 per metric ton of grain. (The actual variance of the real price of wheat in annual U.S. data, 1950-80, is $840 per metric ton, in 1972 dollars.)

1/Metric units are used for aggregate grain quantities because the domestic units involve differing weights per bushel.

Second, price behavior under the same market conditions was simulated assuming an optimally managed increase of 5 million metric tons of grain in mean stocks. This increase in stocks reduced the variance of price from $970 to $800 per metric ton. That is, the standard deviation of price is reduced from $31.20 to $28.30 per metric ton, about 10 percent. This is of course a rough estimate, but its order of magnitude is not extremely sensitive to several alternative assumptions considered about how a 5 million metric ton net increase in mean stocks would impact the grain markets.

Supposing that stabilization of this magnitude is attainable, what is its value to the Nation? How much should we be willing to pay for it? This question is theoretically less well settled than most considered in this report. Perhaps the most widely used approach is that of Massell, as adapted for agricultural commodities by Turnovsky. 1/ This approach is based on expected changes in consumers' and producers' surpluses. Turnovsky's formula, adapted to the present situation, is:

$$E(G) = \frac{a + b}{2} \Delta\sigma_p^2$$

where E(G) is expected annual gain to consumers and producers jointly, a and b are the absolute values of the slopes of supply and demand curves, and $\Delta\sigma_p^2$ is the change in the variance of price. Suppose that a = 0.88, with quantity measured in million metric tons of wheat and corn aggregated, and b = 0, because supply is determined before each year's price is known. The value a = 0.88 corresponds to an elasticity of demand of -0.4. 2/ With these values E(G) = $75 million.

There are a number of caveats to be kept in mind about this estimate. First, the estimated gain is sensitive to the values of supply and demand elasticities and the estimated reduction in price variance caused by the FOR, none

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1/B.F. Massell, "Price Stabilization and Welfare," Quarterly Journal of Economics, May 1969, pp. 284-298; S.J. Turnovsky, "Price Expectations and the Welfare Gains from Price Stabilization," American Journal of Agricultural Economics, Vol. 56, 1974, pp. 706-716.

2/This value is adapted from results for wheat in B. Gardner, "Optimal Stockpiling of Grain," Lexington Books, 1979, ch. 6.

of which are known precisely. For example, estimates of the elasticity of demand for wheat range from almost zero to more than one. If we allow the sum of the elasticities in absolute value to range from 0.3 to 0.8, the resulting values of E(G) range from $56 million to $150 million.

Second, the $75 million is the expected annual gain to the Nation's consumers and producers jointly, but there may be much larger redistribution between consumers and producers. Unfortunately, it is impossible to forecast which group will gain and which will lose without knowing more about the form of the supply and demand functions. For the United States as a whole, the distributional issue may be important because foreigners are important consumers of U.S. grains. Therefore, if stabilization redistributes income from producers to consumers (which it will do if the demand curve for U.S. grain is log-linear in form; i.e., has constant elasticity), then E(G) will be reduced from the values calculated above. Indeed, the United States as a whole could be made worse off than with no stabilization. On the other hand, if stabilization redistributes income from consumers to producers (which it will do if the demand for grain is linear), then gains to the United States are greater than indicated by E(G). Unfortunately, not enough is known about the functional form of the demand for grain to determine which case holds.

Third, the concepts of producers' and consumers' surpluses do not have quite the traditional meaning in application to a product, like grain, which is not directly consumed but is used as an input in producing consumption items, in this case grain-based foods and animal products. The appropriately defined demand and supply curves for present purposes do not hold end-product prices or other input prices constant. This is the approach that was taken in the estimate of the -0.4 demand elasticity, although the estimate is not precise enough that it would have made a noticeable difference if a partial (other prices constant) demand function had been used. The result is a measure of the sum of consumers' and producers' surpluses that includes rents at all levels of production plus end-product consumers' surplus. 1/

1/R.E. Just and D.L. Hueth, "Welfare Measures in a Multi-market Framework," American Economic Review, Dec. 1979, pp. 947-954; G.S. Collins and D.E. Ray, "Welfare Measures for a Price Distortion in a Multi-Product Multi-Factor Setting," prepared for 1980 AAEA meetings, Urbana, Illinois.

Fourth, the simulations of σ_p^2 assume serial independence of random deviations in production and demand; that is, the expected value of production or demand in year t does not depend on temporary shifts in production or demand in year t-1. This assumption is particularly questionable for feed demand. For example, a crop shortfall in year t may generate a reduction in cattle numbers which will reduce the demand for grain in year t+1. This will result in price declining more sharply following a high-price year than would be observed under serial independence. With rational expectations by producers, however, they would anticipate the future price decline and so would not adjust cattle numbers so sharply to a transitory price rise. The extent of "cobweb" price movements depends on the dynamics of adjustment to grain price changes. Because the size of σ_p^2 in the simulations is in the neighborhood of observed grain price variability, it seems unlikely that these considerations would substantially change the expectation of gains from stabilization over a period of years, although the time path of distributional gains and losses could be altered considerably. However, this is an empirical issue beyond the scope of this study.

Fifth, the calculations of surpluses ignore possible gains from the avoidance of some macroeconomic dislocations due to severe price movements and utility losses to risk averse individuals under such circumstances. There are no estimates of the magnitude of these gains, but they clearly have been taken seriously by economic policymakers, mainly as a consequence of hypothesized general inflationary effects of the grain price increases of 1972-74.

To obtain an estimate of the net social return to the FOR program, the $75 million estimate of producer and consumer gains, which we see now to be extremely uncertain, must be compared with the costs of the FOR program. The main governmental costs are the storage subsidy payments. If these are $10 per metric ton, and interest rate subsidies or waivers amount to another $5 per metric ton, then the assumed mean FOR stock of 200 million metric tons will have a mean annual cost of $300 million, not counting ASCS administrative costs. Thus, the FOR program with stabilization effects as assumed in the simulations results in an expected net loss of a little more than $200 million per year. However, this loss is not quite appropriate for considering the welfare effects on the Nation as a whole. The reason is that assumption producers would have stored and paid for three-fourths of the FOR grain anyway. Therefore, $225 million of the $300 million of the Government's cost is a transfer to farmers and is not a net

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cost to the Nation as a whole. In addition, Government costs are reduced to the extent that FOR market support in low-price years reduces deficiency payments.

From the point of view of efficient resource allocation, the cost of the FOR is all the resource costs, whether borne by the Government or not, of the net addition to stocks caused by the FOR. The storage facility, handling, and quality-control costs are roughly accounted for in the $10 per metric ton storage fee, or $50 million for the net additional mean stocks of 5 million metric tons. The main cost beyond this is the interest foregone on capital tied up in the stocks. At a price of $125 per metric ton ($3.41 per bushel of wheat), with an interest rate of 9 percent, the annual interest charge on 5 million metric tons is $56 million. Thus, the social cost of the FOR is about $106 million, approximately the same as the gains. The point estimate of the ratio of benefits to costs is 75/106 = 0.71. There is an additional net loss to the country roughly equal to the administrative costs of setting up the program, making and enforcing program decisions, checking on compliance and quality control by participating farmers, and so forth.

The distinction between governmental costs and net social costs may be clarified by figure 11. The subsidy of $10 per metric ton reduces the marginal cost (MC) of storage from $16.25 to $6.25, thus increasing mean stocks from 15 to 20 million metric tons. The marginal benefits of additional stocks decrease with addition to stocks but are positive over the whole range considered. The calculation that 5 million metric tons of additional stocks yields an increase of $75 million in social benefits is an estimate of area b + d. The governmental costs are a + b + c. The alternative calculation of social costs recognizes that area a is a transfer, not a net resource cost, and that the real resource costs of additional storage are area b + c + d, so that the net social cost is given by area c. Area c corresponds to the $31 million in net social loss implied by the $106 million in social cost calculated above minus the $75 million expected gains.

Going back to the way in which E(G) was derived, this estimate of social loss is the statistically expected loss over a long period of years from a program with characteristics like those of the FOR. It is not an estimate of losses actually incurred in the first 3 years of the program, which may not have given the program a full and fair test. The gains and losses engendered by the FOR to date are estimated

FIGURE 11

COSTS AND BENEFITS OF SUBSIDIZED STORAGE

DOLLARS
PER TON

16.25

6.25

MC

MSB

MC'

MB

a

b

c

d

e

15   20   MEAN STOCKS
                 (MILLION TONS)
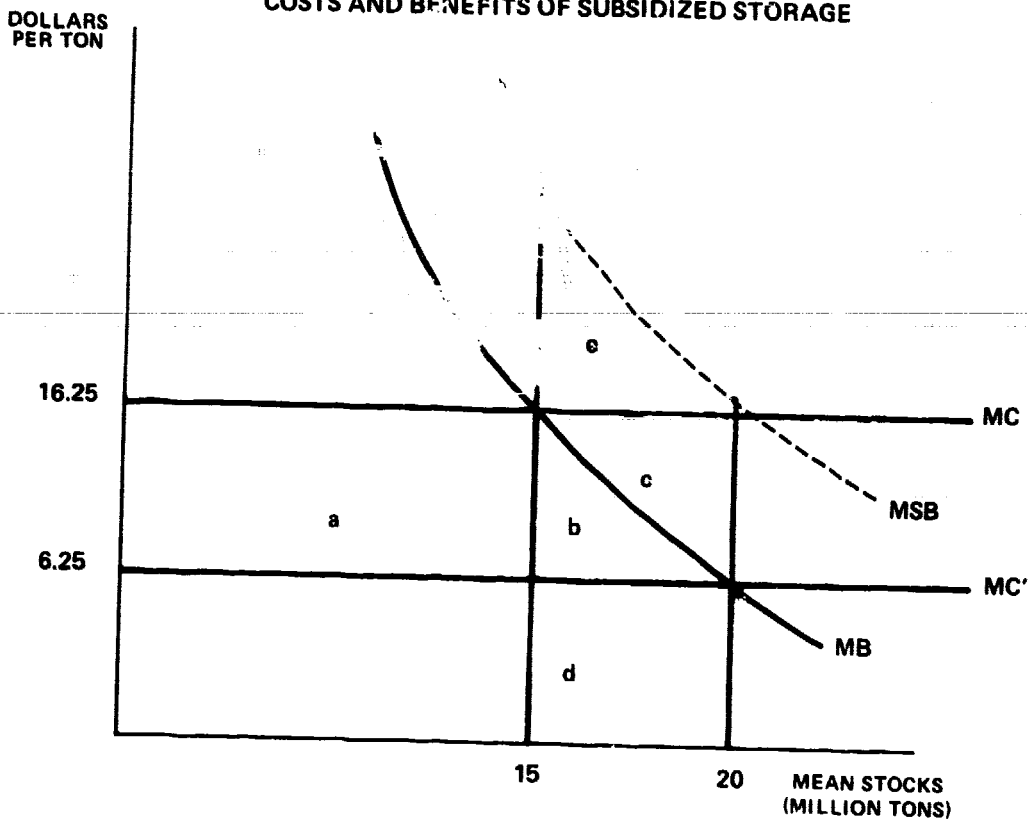
by Just. 1/ This section simulates some broad, aggregate expected effects of the FOR over the range of conditions it appears likely to encounter.

One of the serious limitations of the preceding calculations is worth restating in terms of figure 11. It is the fifth point, which can be expressed as the existence of external benefits to price stabilization associated with increased average stocks. The external benefits for each additional million metric tons of stocks should be added to MB, obtaining a new curve for marginal social benefits, MSB. Accounting for the benefits changes the result from a social loss equal to area c to a social gain equal to area e.

The analysis in this report provides no evidence on the existence or magnitude of these social benefits of a storage program. However, the possibility of net social benefits to stabilization apart from the benefits that can be perceived in the grain markets (external benefits) is very important for policy choice. It implies that a storage/stabilization program may be socially worthwhile despite measured private benefit/cost ratios less than 1. On the other hand, some recent work casts doubt on the assumption that external benefits are really very large. 2/ This area should receive further research. In the meantime, it seems most prudent for U.S. policy to proceed, assuming that at least some external benefits exist which warrant public effort at stabilizing grain markets. Whether better alternatives than the FOR exist is considered in the next section.

1/R.E. Just, op. cit.

2/E. Gramlich, "Macro Policy Response to Price Shocks," Brookings Papers on Economic Activity, 1979; C. Van Duyne, "The Macroeconomic Effects of Commodity Market Disruptions in Open Economies," Journal of International Economics, 1979; M. Finger and D. De Rosa, "Commodity Price Stabilization and the Ratchet Effect," The World Economy, 1978.

SECTION 8

POLICY ALTERNATIVES

The question considered in this section is, given th
evidence on FOR effects, are there alternative policies that
could achieve the FOR's objectives more efficiently?

The objectives as stated in section 1 are (1) price
stabilization and (2) price support for farmers in low-price
periods. The price-support objective alone could be achieved
more readily by policies such as set-asides. The reason is
that when price is supported by increased FOR stockholding,
the very act of supporting current price creates future sup-
plies which necessarily reduce the expected level of price in
the future. But when price is supported by set-asides, no
such stocks are created. However, from the point of view of
the Nation as a whole, this is not a valid criticism of the
FOR. In this discussion of policy alternatives, we will
assume that the primary criterion for evaluating alternative
policies is that they should maximize the well-being of pro-
ducers, consumers, and taxpayers jointly. The mechanism
for accomplishing this maximization is efficient stabiliza-
tion That is, we will assess policy alternatives principal-
ly in terms of their efficiency in achieving objective 1.
Objective 2, aimed at increasing farmers' returns, is in this
sense desirable only to the extent that increasing farmers'
returns promotes the general interest; that is, to the ex-
tent that objective 2 fits in with objective 1. 1/

The main policy options that should be considered, in
the author's view, are the following:

1. Continue the FOR essentially as is.

2. Continue the FOR but with one or more of the follow-
    ing changes:

    a. Permanently remove upper limits on eligible
        quantities of grain.

    b. Operate the program with long-term rather than
        short-term stabilization in mind.

1/If one does not accept this narrowing of the objectives to
  the price stabilization objective, and gives primary empha-
  sis to boosting farmers' returns, then the FOR (or any other
  stockpiling program) is inferior to production-control
  policies, for reasons just stated.

<ol type="a" start="3">

       c.   Make future adjustments in support, release,
            and call prices according to a published and
            stable rule.

       d.   Permit grain merchants, millers, exporters, and
            other middlemen to participate in the program.

       e.   Ensure that FOR grain is actually stored from
            one crop year to the next.

       f.   Increase release and call prices substantially
            relative to loan rates.

3.   Continue storage subsidies as under the FOR but
     without release or call triggers, or upper limits on
     stocks, and permit anyone who wishes to store grain
     from one crop year to the next to enter the program.

4.   Discontinue FOR but retain:

       a.   Subsidized storage facility loans.

       b.   Government-held emergency stock of 5 to 6
            million metric tons.

       c.   CCC loan program with relatively low support
            price and release price.

5.   Discontinue FOR and return to CCC storage with high
     loan prices as in the 1960s.

6.   Discontinue FOR, keep CCC loan rates low, and rely
     on unsubsidized private storage for price stabiliza-
     tion with no public stocks of any kind ("free-
     market" option).

    The pros and cons of each alternative will be discussed
as compared with option 1, continue the FOR essentially as is.

    Option 2a was put into effect for corn in 1980, and the
only change would be to make this a standard, permanent feature
of the program. The reason for keeping the upper limit on FOR
stocks off is that the presence of an upper limit tends under
some circumstances to reduce the net addition to total stocks
caused by additions to FOR stocks. Knowledge that no ceiling
on FOR stocks will limit its price-supporting capability in
years of excess supply will encourage the holding of private
stocks outside the FOR, as compared with the existence of a
limit, because the probability of a further price decline is
reduced by the absence of a limit. The drawback of permanently
removing the limit on FOR stocks is that flexibility is lost

for governmental management of the program if for some
reason it appears that farmers wish to place "too much"
grain in the program. So one might argue for governmental
discretion to impose, remove, or change the limit at will.
However, anything that increases the probability of a limit
being imposed will reduce the incentives for private stock-
holding. The magnitude of this effect is unknown and is
probably relatively small. But because a major weakness
of the FOR has been a rather low effectiveness in increasing
total stocks, any step that can encourage private stockhold-
ing under the FOR should be considered carefully.

Option 2b states more directly a general point that has
already emerged in 2a. The FOR has been operated with much
closer attention to short-term month-to-month, week-to-week,
even day-to-day price fluctuations than the basic objectives
of the program require. The price stabilization of most
value to consumers, producers, and the economy generally
occurs on a yearly basis, between years of plenty and years
of dearth. Only seldom would fundamental supply/demand
changes occur more than once within a crop year. These
instances might involve Southern Hemisphere crop failure
or a serious and persistent international crisis. Why not
have the FOR attempt to smooth out short-term, intraseasonal
price moves as well? This would undoubtedly be a real
service if it could be done. However, we could find no
evidence that the FOR has been at all effective in short-term
stabilization. There is even some indication that the
program moves have been destabilizing. The successes of
the program to date involve its role in increasing, albeit
modestly, total carryover stocks. It is not clear that
the short-term triggering of releases and calls and changes
in program provisions have contributed at all to the success.
These perturbations seem more likely to have contributed
to the modestness of the success; that is, to have increased
the cost of the degree of long-term stabilization potential
achieved.

The operational issues in short-term versus long-term
orientation of the FOR involve questions such as how long
market prices must remain above the release level, say,
before storage payments are stopped. The issue has not been
studied in this report. USDA should consider it carefully.
The order of magnitude of adjustment that should be considered
is, instead of using the trend in a 5-day moving average,
to base program decisions on a 5-month moving average within
the crop year, after an initial decision on the status of the
program for the coming year based on the situation following
the first reasonably reliable crop forecasts, say on August
15 of each year. This scheme in particular is not proposed,
but simply a study of ways to put a long-term focus in the

program. The FOR should not be caught up in the complexities of short-term price fluctuations, and USDA should not attempt to become the short-term manager of U.S. grain markets. The longer term focus would not only avoid the complexities created by continual changes in the overall program, but would also keep the program from being bogged down in transitory State and regional events arising from transportation tie-ups, storage capacity crises, strikes, or other episodes which to date have added greatly to the complexity of the FOR program without adding anything to the Nation's carryover stocks of grain.

Option 2c is closely related to 2b in that an important part of moving to a long-term orientation is stating ex-plicitly that this is the program's primary goal. The long-term orientation is made even clearer by making adjustments in trigger prices according to rule rather than discretion. The drawback of giving up discretionary changes is that the Government has less flexibility in responding to changing circumstances. The arguments are analogous to those raised in the issue of rules versus discretionary authority in monetary policy. In this macroeconomic area, the most recent policy moves in both the Congress and in the Federal Reserve Board are, after a long struggle against them, to accept rules. The emerging realization is that while rules are in-ferior to discretion by an ideally operating, fully informed regulatory body, rules are superior to discretion as it can reasonably be expected to be conducted given imperfect knowledge and incentives. The argument for rules in the FOR is basically the same.

The main adjustments that should be made in support, release, and call prices relate to changes in the general price level and to changes in the underlying supply/demand situation for grains. Adjustment for the general price level could be made by increasing all trigger prices an-nually by the same percentage as the GNP deflator. Ad-justing for the underlying supply/demand situation is more difficult. It could perhaps be tied to an annual deter-mination such as the Secretary of Agriculture is now re-quired by law to make in determining set-aside and other grain program decisions. How to systematize rulemaking for the FOR requires much study, an investment which USDA should undertake. The point here is that some such approach is fundamental in reorienting the FOR to its long-term stabilization objectives.

Option 2d is aimed at increasing the ability of the FOR to create net additions to total stocks and to reduce the social cost of storing the additional grain. The problem with subsidizing storage by farmers only is that there may

be nonfarmers who could expand their stocks at the same or lower cost than farmers but are in fact induced by the FOR program to contract their stocks. The reason is as follows. Merchants, exporters, millers, or other middlemen will be induced to hold stocks just as farmers will, when the expected price gains exceed the costs of storage.

Suppose that for both farmers and nonfarmers the costs are 25 cents per bushel at the margin. Then we expect storage to increase until the expected price gain is roughly 25 cents per bushel. Now we allow farmers a 25-cents per bushel subsidy for storage. Their storage costs are now essentially zero. Therefore, they will add to stocks until expected price gains are essentially zero. But now that expected price gains are zero, how much will nonfarmers store? They will cut back their storage until the marginal cost of storage is zero. That is, they will cut back storage to the level at which the convenience benefits of having the grain on hand in inventory justify the costs. (Nonfarmers will eliminate all speculative stocks and keep only working stocks, in the trade jargon.) This clearly both blunts the purpose to the FOR in increasing stocks in low-price years and increases the cost of storage for the stocks held. Middlemen will have storage capacity available at lower cost than farmers are paying for on-farm storage.

In principle, the differential cost could be eliminated by having nonfarmers rent storage space to farmers who own the FOR grain and receive the subsidies. And in fact this does occur under the FOR. But it seems clear that the storage capacity of some nonfarm interests, by reason of location, size, or convenience, is not suited for rental to farmers. This storage capacity could be used more effectively if its owners were eligible for the FOR program. Unfortunately, neither data nor analyses exist that permit a quantitative assessment of this effect. It is an area that USDA should research in its FOR assessment.

There are three objections to making nonfarmers eligible for the FOR. First, there would be some paying of subsidies to nonfarmers, as there currently is to farmers, for storage of grain that would have been stored anyway. Second, the quantity of stocks owned by nonfarmers was quite small even before the FOR was implemented. Therefore, the paying of subsidies to nonfarmers would be unlikely to make a large difference in total stocks. Third, an explicit, if secondary, goal of the FOR has from the beginning been to enable farmers as opposed to middlemen to control and profit from carryover storage of grain.

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While these objections must be taken seriously, the balance should not rest with them in the author's opinion. The more fundamental problem is that the FOR has not been as effective as it should be in promoting larger total stocks of grain. In the interest of improving the FOR as a long-term stabilization program, these objections should give way if any significant increase in stockholding can be achieved by making nonfarmers eligible.

Option 2e also increases the FOR's effectiveness in adding to the Nation's carryover stocks. As discussed in section 4, ASCS procedures, and probably even more so the unauthorized switching of new-crop for old-crop FOR grain at harvest make it easy for FOR stocks to add little to the actual carryover. This option would involve an end to the practice of permitting farmers who are short of storage space at harvest time to sell old-crop grain and then replace it with new-crop grain. Farmers who do not actually carry old-crop grain into the new crop year should not be eligible for the program. And there should be increased surveillance by ASCS to make sure that there is no unauthorized sale-and-replacement of FOR grain.

The drawback of this option is that it would involve considerable expense to enforce. Also, the seriousness of the problem could not be estimated accurately without a quite involved investigation of farmers' actual practices in handling FOR grain. Nonetheless, this investigation and action should be undertaken if the FOR program is to be truly effective in increasing the Nation's carryover stocks. 1/

Option 2f is one that will undoubtedly be considered seriously by policymakers, even if options 2a through 2e are not. However, a proper analysis of the pros and cons here is perhaps more difficult than for any of the others. A dilemma is created by the fact that the FOR program (as compared with no program) reduces the probability of observing prices above the release price, but increases the probability of prices rising up to or just below the release price. The latter phenomenon arises because the rate of sales out of FOR stocks when price rises will tend to be reduced by the incentives of the FOR contracts, and the rate of sales out of non-FOR stocks will be reduced

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1/A prohibition on substituting new-crop for old-crop grain at harvest time is not a prohibition on rotation of stocks as a means of quality control. It would, for example, be perfectly acceptable in the spring of 1981 to substitute 1980-crop for 1979-crop wheat in the FOR.

because their owners will know that FOR stocks will not appear on the market until the release level is reached. Thus, we expect non-FOR stocks to appear on the market most intensively at prices just below the release price, and FOR stocks to appear most intensively at or above the release price. On the other hand, when supply prospects become large, prices tend to fall relatively quick to the support level because the existence of large FOR stocks at higher prices leaves less room for speculative accumulation of private non-FOR stocks as price falls.

Thus, the incentives for speculative storage under the FOR program suggest a tendency for prices to be relatively often at or near the floor price or else at or near the release price, as compared with intermediate prices. The actual price data in the FOR period in fact showed more price variability than pre-FOR data, and the FOR price distributions suggested a bimodal distribution of probabilities.

If the FOR increases the instability of prices within the price bands, this effect can be reduced by bringing the loan rate and release prices closer together. But this creates problems also. First, the closer the release price is to the loan rate, the less scope there is for private speculative storage outside the FOR. For example, if storage costs, including interest, are 50 cents per bushel, and the release price is 40 cents above the support price, there is virtually no chance for a price gain large enough to repay unsubsidized carryover storage costs (unless FOR stocks are very small). Second, and more fundamentally, a low release price encourages farmers to sell grain at relatively low prices. But the most important social benefits of the FOR, especially from the point of view of avoiding disruptions of the general economy, is to promote the holding of stocks even at relatively high prices so that they will be available when very rare but socially disruptive extreme shortages occur, as in 1973-' . A low release price will do relatively little to promote stock-holding for this purpose.

In short, this is the dilemma of the release/call trigger mechanism: If the release price is relatively low, then FOR stocks will not be available when stocks are most needed. If it is relatively high (say twice the loan rate), then more instability is created between the upper and lower price bounds. The present program straddles these alternatives and so provides some of the drawbacks of each. Unfortunately, not enough is known about either the probability distributions of price outcomes under alternative release prices or the frequency or social costs of future severe shortages to enable a scientific choice of

release/call trigger levels. More seriously, no data base sufficient to support research that would identify "optimal" price bands exists. In this case, a call for further study is an empty call.

Option 3 deserves serious consideration, for one reason, because of the lack of the knowledge necessary to specify the appropriate release and call triggers. A more fundamental reason is that a simple subsidy without triggers is likely to generate a higher ratio of social benefits to costs than any price triggers. The reason is that the triggers, no matter where they are set, introduce discontinuities or "corners" in incentives faced by market participants. These lead to sub-optimal allocation of storage resources in the neighborhood of the triggers. 1/ The argument against a simple subsidy is that farmers may respond irrationally to price changes and fail to sell when they should sell after prices have risen, say, to $6.50 per bushel for wheat. However, the case against allowing farmers to decide when to release stocks requires not only that the farmers be mistaken but also that USDA be correct. In fact, in the last episode when stocks were sold too soon (as it appeared in retrospect), it was USDA and not farmers that appear to have made the poor judgments. 2/ In the author's view, USDA ought to give serious consideration to allowing farmers a chance at unrestricted management of their stocks through an unrestricted subsidy for grain stored from one crop year to the next.

Option 4 is intended to improve the FOR by (1) encouraging stockholding at the margin, (2) minimizing the reduction in private stocks caused by the increase in publicly controlled stocks, (3) increasing the probability that stocks will be available to combat extreme shortage situations, and (4) relying on unsubsidized farm and commercial storage for ordinary trade and stabilization purposes. The storage facility loan program is directed at (1). It concentrates its subsidies on reducing costs of storage at the margin, and it does not discourage private stockholding. The Government-held emergency stock seems to be the best way to provide stocks for periods of extreme shortage involving externalities not incorporated in the expected profits of private stockholders. This is not

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1/For detailed argument on the suboptimality of price triggers, see Gardner, "Optimal Stockpiling of Grain," op. cit., and Sharples, "An Alternative Grain Reserve," op. cit.

2/Fred Sanderson, "The Great Food Fumble," Science, May 1975, and John Schnittker, "The Food Price Inflation of 1972/73," Brookings Papers on Economic Activity, Vol. 2, 1973.

a new departure, of course. Current policy envisages such a stock. In order that the negative impact on privately held storage be minimized, these stocks would not be released until price was well above the price expected to prevail under average conditions, perhaps 75 percent above such a "normal" price, maybe $6.25 per bushel for wheat and $4.20 per bushel (in 1980 dollars) for corn. Because the emergency situations that these stocks would deal with would be expected to occur only rarely, perhaps 1 year in 10, it is important that the upper limit on the quantity be kept small, perhaps 5 million or 6 million metric tons of corn and wheat (roughly 2 percent of normal production). The price for acquiring these stock: should be kept relatively high also, perhaps slightly below the current FOR release prices, to ensure their availability. Neither the acquisition nor the release price should be rigidly tied to the loan rate, because of its sensitivity to price-support politics. And this storage program should not be manipulated to serve short-term changes in policy, as the FOR was following the 1980 embargo.

For ordinary market-stabilization purposes, option 4 relies on private storage for carryover stocks. The CCC loan program would continue with its present low support levels for loan periods of less than a year. CCC-acquired grain should be put back on the market at relatively low prices, say 15 or 20 percent of the support price. The point is not to have CCC stocks held for long periods and thus increase pressure for set-asides.

Option 5 appears clearly inferior to retaining the FOR essentially as is. The FOR has given farmers more control over stocks management than they had under the old programs, and it would probably be a mistake to return to massive governmental ownership of stocks. More fundamentally important may be the connection of the FOR with support prices substantially lower in real terms than under earlier policy regimes. To the extent that the FOR has, by providing temporary price support outside the traditional mechanisms, permitted lower CCC loan rates, it has been a notable policy improvement. Thus, while this report has been critical of the FOR program, we are not implying that it would be better to return to the approaches of the 1950s and 1960s.

Option 6 would eliminate substantial governmental costs and would probably not increase price instability compared with the FOR as much as we have formerly believed. At least the 1975-77 pre-FOR period does not look bad compared with our experience under the FOR. But a free market in grain with low support prices is probably not possible politically. And there are arguments which must be taken seriously that on

average too little grain would be stockpiled, from a social point of view, in a wholly unregulated market. However, it is quite possible that the social benefits of increased stability could be obtained more efficiently by means other than grain storage programs. This appears especially true in the international stabilization context. 1/ For U.S. internal stabilization, too, forward contracting, and futures, options and insurance markets may over the long term provide mechanisms for stabilizing farmers' returns and grain users' costs more efficiently than subsidized storage or other interventions in the grain markets. Policy alternatives along these lines should receive serious consideration, including further development and evaluation of a wide range of stabilization policies. Nonetheless, option 6 involves deregulation of the grain markets too extreme to be practical at this time.

Overall, while options 5 and 6 do not present strong practical alternatives to the FOR in 1981 legislation, options 2 to 4, or at least parts of them, do. Assessment of the FOR should not be reduced to "if it ain't broke, don't fix it." While it is not possible to draw firm conclusions about all aspects of the FOR program based on events to date, two major weaknesses stand out. On the evidence adduced in this report, the FOR seems not to have been cost-effective in adding to stocks and hence promoting long-term stability, and it seems to have been completely ineffective and perhaps even counterproductive in promoting short-term price stability. Therefore, the alternatives specified in options 2 to 4, as potential remedies for these deficiencies, should receive serious consideration by the Congress and USDA.

1/See D.G. Johnson, "Limitations of Grain Reserves in the Quest for Stable Prices," The World Economy, Vol. 3, June 1978, pp. 289-299.