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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Farmer–Owned Grain Reserve Program Needs Modification To Improve Effectiveness

Volume 1 Of Three Volumes

The Department of Agriculture's farmer-owned grain reserve program was authorized in 1977 to allow producers to store grains to provide for orderly marketing and stable prices. The program has not fully met its objectives because it has not

--materially increased grain inventories as intended,

--removed the Government from its role as a significant grain storer, or

--reduced price variability.

The reserve contains some grain of questionable quality, and storage payments have exceeded storage costs.

To improve its effectiveness, modifications should be made in program adjustment methodology. Also, GAO recommends actions to improve the quality of reserve grain and to limit storage payments.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the Department of Agriculture's administration of the farmer-owned grain reserve provisions of the 1977 Food and Agriculture Act. It identifies certain areas in which the Department could improve program administration and thereby improve overall program effectiveness. It discusses particularly the reserve program's impact on grain stock levels, grain prices, consumer prices, and the meat industry. It also recommends modifications that are needed to assure reserve grain quality and to assure that storage payments do not exceed storage costs.

We are sending copies of this report to the Director, Office of Management and Budget, and to the Secretary of Agriculture.

Milton J. Socolar
Acting Comptroller General
of the United States

PREFACE

GAO and two agricultural economists reviewed the farmer-owned grain reserve program. This volume 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.

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

Volume	Description
2	Consequences of USDA's Farmer-Owned Reserve Program for Grain Stocks and Prices--examines data on stocks and prices of corn and wheat during the program's first 3 years and estimates its effects.
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.

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

FARMER-OWNED GRAIN RESERVE PROGRAM NEEDS MODIFICATION TO IMPROVE EFFECTIVENESS

D I G E S T

The farmer-owned grain reserve, authorized by the Food and Agriculture Act of 1977 and administered by the Department of Agriculture's Agricultural Stabilization and Conservation Service, is to encourage producers to store wheat and feed grains when they are in abundant supply and extend the time for their orderly marketing.

GAO and its consultants found that during its first 2 to 3 years, the farmer-owned reserve only partially met its objectives of increasing grain inventories in times of abundant supply, removing the Government from the role of grain storer, and reducing price variability. Also, some reserve grain is of questionable quality and storage payments have exceeded storage costs. GAO recommends program modifications to improve effectiveness, assure grain quality, and limit storage payments to storage costs.

As of March 18, 1981, the reserve contained about 1.22 billion bushels of wheat, corn, and other grains. The value of outstanding loans on these reserve grains was about $2.9 billion. The reserve grain cannot be sold without penalty until predetermined market price levels--known as release and call levels--are reached. At release, producers may, but do not have to, remove the grain from the reserve. At call, producers must repay their loans or forfeit the grain. (See pp. 1 to 5.)

THE FARMER-OWNED RESERVE HAS NOT FULLY MET ITS OBJECTIVES AND NEEDS MODIFICATION

Analyses of grain market events before and after the reserve came into effect show the reserve had little effect on increasing inventories. Most reserve grain would have been held in private stocks without the reserve. (See pp. 10 and 11.)

Although the reserve initially succeeded in ensuring producer ownership of reserve stocks, the

Government now holds grain purchased in reaction to the Russian grain embargo. (See pp. 12 and 13.)

The degree of price stability attributable to the reserve is minor. One of GAO's consultants estimated that over its first 2 years, the reserve may have resulted in a net economic loss of $4.4 billion for the total U.S. economy, due in part to livestock industry maladjustments. However, he added that, in the long run, gains could conceivably exceed costs. (See pp. 13 to 16.)

The short period covered by the analyses may not provide an adequate test of the reserve's long-term influence or effectiveness. Program modifications are needed, however, to improve the program's effectiveness. (See pp. 17 to 22 and 24.)

Recommendations

To improve the reserve's effectiveness, the program should be modified to provide for methodical adjustments in program operations while still allowing for some necessary flexibility.

Other program modifications, such as removing quantity limits, emphasizing long-term stabilization, and allowing nonproducers to participate, are possible, but the Secretary of Agriculture should study their feasibility before implementation is considered. (See p. 24.)

SOME RESERVE GRAIN QUALITY IS QUESTIONABLE

Department studies have shown that although most farm-stored reserve grain is of acceptable quality, some is of questionable quality due to high moisture, insect infestation, high kernel damage, contamination, or other conditions.

Based on a random quality check, the Service projected that up to 17.9 percent of the total reserve grain as of September 30, 1979, contained some nonstorable (musty, sour, distinctly low-quality, heat damaged, and/or high moisture) or insect-infested grain. Also, in March 1980 the Department's Office of Inspector General projected, with 95-percent confidence, that at least 6.8 percent and as much as 13.9 percent of the reserve corn and wheat in the five States it reviewed--where about 79 percent of the reserve's farm-stored grain was located--was U.S. Sample grade, the lowest quality designation under U.S. grain standards. (See pp. 27 to 30 and app. II.)

The questionable-quality grain results from low-quality grain entering the reserve and/or grain deteriorating in storage. GAO found that guidelines for determining the quality of grain entering the reserve are inadequate and that some producers have not followed proper grain storage procedures, such as fumigating and rotating grain, monitoring grain quality, and controlling moisture. (See pp. 30 to 33.)

The Service has not promptly followed up on cases involving questionable-quality grain. In 55 cases in three counties involving quality problems, the Service's county officials had asked the producers to correct the problems and report the action taken. County officials followed up with only 1 of 31 producers who did not report back. (See pp. 33 to 35.)

Paying storage and incurring other program costs for questionable-quality grain is not an effective or efficient use of Federal funds. Also, grain which has diminished in volume or nutritional quality results in a loss to consumers, brings less revenue to producers, and may jeopardize the adequacy of reserve loan collateral. (See pp. 35 and 36.)

Recommendations

The Secretary of Agriculture should require the Service to obtain official grade determinations, on a sample basis, as grain enters the reserve and on the same grain each subsequent year (where possible) to develop a profile of reserve grain and to determine what characteristics are predictors of storability. Also, the Service should improve its guidelines and procedures for identifying loans for which grain with quality problems serves as collateral and correcting or eliminating quality problems identified. (See p. 38.)

STORAGE PAYMENTS EXCEED STORAGE COST

GAO estimates that payments for onfarm reserve storage in 1979 exceeded the estimated average cost of storing the grain by at least $28 million. The fiscal year 1979 storage payment rate was 25 cents a bushel. Based on a representative random sample of storage facility loans made in

1979 and other information, GAO estimated that the average cost of onfarm storage was 21.7 cents a bushel, assuming a 10-year useful bin life. It was even lower assuming a 20-year useful bin life. (See pp. 40 to 42.)

Recommendation

The Secretary should determine the average cost of reserve grain storage and limit storage payments to this amount. Both onfarm and warehouse storage costs should be considered in determining the average cost. (See p. 46.)

STORAGE EARNINGS ALLOWED TO CONTINUE AFTER CALL STATUS WAS REACHED

Although the call status is intended to force grain from the reserve, Service procedures in effect until October 1980 allowed producers to earn an estimated $900,000 in storage payments after barley was in call status. Storage earnings also continued after oats and sorghum reached call status. The Service has changed its procedures to stop the earning of storage payments when a grain is placed in call status. However, it did not amend program regulations to make them consistent with these procedures. (See pp. 42 to 45.)

Recommendation

The Secretary should amend program regulations to make them consistent with Service procedures which provide that storage earnings stop in all cases when a grain reaches call status. (See p. 46.)

UNEARNED PAYMENTS NOT COLLECTED PROMPTLY

The Service allowed producers to retain unearned storage payments for an unreasonable period of time when the redemption period was extended. In some cases, the payments were retained up to 10 months beyond call. The Service has amended its regulations to provide that interest be charged immediately following the maturity date or the originally required settlement date. (See pp. 45 and 46.)

AGENCY COMMENTS

The Department agreed that the program should be modified to provide for methodical adjustments in program operations, while still allowing some flexibility, and that procedures for correcting quality problems could be improved.

It agreed that the average storage cost should reflect both onfarm and commercial warehouse storage costs, but it said that ascertaining the average cost of storing reserve grain is difficult.

The Department said that obtaining official grade determinations on reserve grain to identify what characteristics are predictors of storability would require an effort of considerable magnitude with a promise of negligible payoff. It added that its experience had shown that essentially two elements--excess moisture and insects--increase the probability of grain quality deterioration. GAO believes that other factors, such as the uniformity of quality and the cleanliness of grain, can also contribute to deterioration and that information on these characteristics and their impact on grain quality would be useful for future reserve program decisions.

The Department said that it believed the procedure for identifying quality problems was adequate. However, the Service has acknowledged problems in controls over loan collateral, including sampling and inspection procedures. A proposed Service handbook, planned for release in late 1981, should help strengthen these procedures which, when properly followed, should help assure that quality problems are identified. (See app. III and pp. 24, 38, and 47.)

Contents

ABBREVIATIONS

AMS	Agricultural Marketing Service
ASCS	Agricultural Stabilization and Conservation Service
CCC	Commodity Credit Corporation
ESS	Economics and Statistics Service
FDA	Food and Drug Administration
FGIS	Federal Grain Inspection Service
FOR	farmer-owned reserve
GAO	General Accounting Office
MMT	million metric tons
OIG	Office of Inspector General
SEA	Science and Education Administration
USDA	U.S. Department of Agriculture

CHAPTER 1

INTRODUCTION

The Food and Agriculture Act of 1977 (Public Law 95-113, 91 Stat. 913 et seq.) authorizes a producer storage program, commonly called the farmer-owned grain reserve (FOR) program, for wheat and feed grains. The program's objective is to encourage producers to store these grains when they are in abundant supply and extend the time period for their orderly marketing. Its function is to stabilize grain prices, not to provide for emergency or disaster needs.

Under the program, the U.S. Department of Agriculture (USDA) provides loans and storage payments to producers who place their grain in the FOR. The loans mature in 3 years (or earlier if certain conditions are met) and can be extended to a maximum of 5 years. The loans bear interest, unless waived, at rates prescribed by the Secretary of Agriculture. The program is operated through USDA's Commodity Credit Corporation (CCC) and is administered for CCC by USDA's Agricultural Stabilization and Conservation Service (ASCS).

HISTORY OF RESERVE PROGRAMS

An objective of farm commodity programs from the early 1930's to the early 1970's was to support prices and income through supply management or limitation. During this period, the Government owned stocks of grain turned over to it under its price-support program, and at times it maintained large inventories in Government-owned storage facilities. These facilities, purchased from 1939 through 1956, had a peak occupancy of 748 million bushels in 1960. The Government-owned stocks declined from that time until the last stocks were removed and the storage structures were sold in 1974. The Government-owned grain was sold at various times at the Government's option.

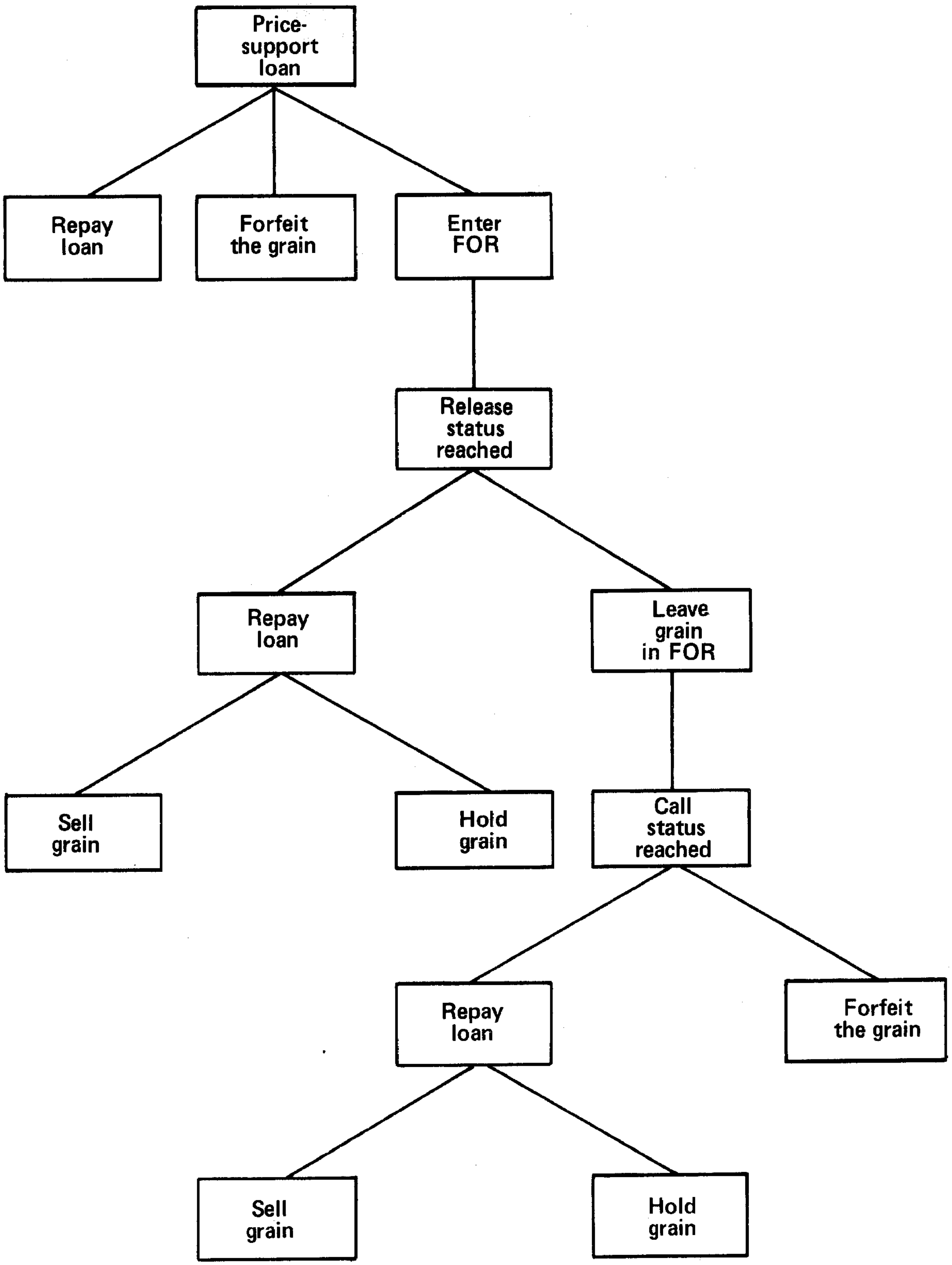
The FOR program, while also supporting prices and incomes, emphasizes the marketing mechanism rather than production control.

HOW THE RESERVE WORKS

Any producer owning designated FOR grains is eligible for a 3-year FOR loan. To qualify for an FOR loan, a producer generally must have had the grain under a price-support loan or have qualified to have such a loan. 1/ When the price-support loan expires, one of the producer's options is to extend the loan for 3 years under the FOR program, if the FOR is open for that commodity at that time. (See chart on p. 2.)

1/The Secretary of Agriculture can allow, and under some circumstances has allowed, producers to place grain in the FOR before maturity of their price-support loans (9 months).

Farmer - Owned Reserve
Producer Options



The CCC Board of Directors has declared wheat, corn, barley, oats, sorghum, and rice as eligible for the FOR. The Board has the authority to specify additional commodities.

Until April 1980 producers had to comply with other USDA program requirements such as set-aside programs (which take land out of production) or normal crop acreage limitations, when in effect, to qualify for FOR program participation. There were no set-aside requirements for 1980 wheat and feed grains. In April 1980 the President signed legislation (Public Law 96-234, 94 Stat. 333) which opened the corn FOR for a limited time to producers regardless of set-aside compliance to help offset the Russian grain embargo's effects.

A participating producer must provide storage space of permanent construction for the grain, either on the farm or in commercial storage space. In return, the producer receives a storage payment which is paid annually in advance. The producer is responsible for maintaining the grain quantity and quality. To fulfill this responsibility, the producer may, with ASCS approval, rotate FOR grain with grain of equal quality and quantity.

Grain stored under this program cannot be sold without penalty until predetermined market price levels--known as release and call levels--are reached. These levels are set as percentages of the then-current loan rate. USDA has changed these percentages twice--in January and July 1980. To identify loans associated with the different release and call levels, USDA divides the FOR into segments as follows.

Reserve I - Contains those commodities entering the FOR before January 7, 1980, unless the producer signed a conversion agreement to reserves II or III.

Reserve II - Contains those commodities entering the FOR from January 7 through August 24, 1980, plus those which converted from reserve I, unless the producer signed a conversion agreement to reserve III.

Reserve III - Contains those commodities entering the FOR on or after August 25, 1980, plus those which converted from reserves I or II.

The release and call levels for the various reserve segments are as follows.

	Wheat		Feed grains	
	Release	Call	Release	Call
	(Percent of then-current loan rate)			
Reserve I	140	175	125	140
Reserve II	150	185	125	145
Reserve III	140	175	125	145

The release level is the level at which a producer can remove the grain from the FOR without penalty. At this level, however, the producer may also choose to leave it in the FOR. At the call level, the level at which the loan is due and payable, the producer has the choice of repaying the loan or forfeiting the grain to CCC. If the producer forfeits the grain, he is liable for payment of the difference, if any, between the loan amount and the value of the grain. (See app. I for a chronology of pertinent FOR events and changes.)

The time at which release and call levels are reached is determined by the national average market price, which is calculated by ASCS using input from USDA's Agricultural Marketing Service (AMS) and Economics and Statistics Service (ESS).

AMS provides daily cash prices from selected major commodity markets for each grain. For example, prices for corn are furnished from the Kansas City, Kansas; Omaha, Nebraska; Chicago, Illinois; St. Louis, Missouri; and Minneapolis, Minnesota, commodity markets. An average of these daily cash prices is derived for the day. This average is then considered with the averages for the previous 4 days, resulting in a 5-day average price. The 5-day average price is adjusted to reflect the daily prices that producers are receiving. The adjustment factor used is obtained by comparing the AMS major market price on or around the 15th of the month with the ESS midmonth price--the average price being received by producers. The ESS price is based on data furnished by mills and elevators throughout the country on or around the 15th of the month.

ASCS is responsible for assuring that grain placed in the FOR is inspected and measured before loan approval. The inspection is primarily visual, but if the loan inspector questions the eligibility of the grain, a sample is drawn for determining test weight, moisture content, or official grade when applicable. If the feed grain (or wheat entering the FOR before August 1980) was inspected and measured when placed under the price-support loan, no additional inspection or measurement is required unless there is reason to believe that some of the commodity has been removed or that the commodity is not in a storable condition. As of August 1980, when program regulations were rewritten so that only food-quality wheat was eligible for the FOR, all wheat must be visually inspected immediately before it enters the FOR. The amount of grain eligible for loan is 100 percent of the measured amount.

USDA charges interest on FOR loans at a rate determined by the Secretary. The interest rates in effect since the FOR program started have ranged from 6 percent to 13 percent. The rate in effect on 1980 crop loans was 11.5 percent. USDA announced in early 1978 that interest charges would be waived after the first year of the loan for all grains in the FOR. To help offset the effects of the Russian grain embargo, the first-year interest was waived on corn entering the FOR between October 22, 1979, and August 24, 1980. Further, the Agricultural Act of 1980 (Public Law 96-494) waived all interest on 1980 and 1981 crop FOR loans.

ASCS procedures require it to inspect all FOR grains at least annually for quantity and quality. In addition, ASCS has made nationwide random quality checks of FOR grains--as of November 1978, September 1979, May 1980, and August 1980. For these checks, ASCS drew samples from each selected bin under loan. The samples were graded by inspectors licensed under the U.S. Grain Standards Act (7 U.S.C. 71 _et seq_.) The results of ASCS's nationwide checks are discussed in chapter 3.

The 1977 act specifies an FOR level for wheat of not less than 300 million bushels nor more than 700 million bushels. For feed grains, the act specifies no limit, and according to an ASCS official, the Secretary has never established formal minimums or maximums. However, under his discretionary authority, he has established informal goals for feed grains from time to time.

Production of wheat and feed grains in the United States in the 1979 crop year was about 11.8 billion bushels. At its peak level the FOR contained about 1.28 billion bushels (as of Jan. 28, 1981).

Grain	Quantity in the FOR Jan. 28, 1981	1979 crop year production
	------(million bushels)-------	
Wheat	271.0	2,134.1
Corn	994.2	7,938.8
Barley	12.9	382.8
Oats	-	526.6
Sorghum	0.6	808.9
Total	1,278.7	11,791.2

As of February 28, 1981, about 86 percent of the FOR grain was stored on farms and the value of outstanding FOR loans was about $2.9 billion. As of March 18, 1981, the FOR contained about 1.22 billion bushels.

PROGRAM ADMINISTRATION

CCC is a wholly owned Government corporation created in 1933 to stabilize, support, and protect farm income and prices; to assist in maintaining balanced and adequate supplies of agricultural commodities; and to facilitate the orderly distribution of these commodities. CCC has no operating personnel; its programs are carried out primarily through ASCS personnel and facilities. ASCS has 50 State offices and an office in the Commonwealth of Puerto Rico. There are 2,745 county offices which administer programs in 3,052 counties. Each State and county has a committee which directs the activities of the respective office.

The county committees administer local operations and are composed of (1) three producers elected by the producers in the county and (2) the county agricultural extension agent who is an ex officio member. They make local program decisions and policies and appoint a county executive director who directs the county office staff in handling the day-to-day, detailed administrative work. The State committees supervise the county committees and are comprised of (1) from three to five members appointed by the Secretary of Agriculture and (2) the State's director of agricultural extension services.

COST OF THE RESERVE

FOR program costs, including storage payments, waived interest, and ASCS administrative costs, represent a significant Government cost. However, these could be partially offset by interest income and by reductions in deficiency payments resulting from any grain price increases due to the FOR.

ASCS makes advance storage payments to participating producers annually. The producers earn the storage payments during the ensuing year. Producer storage earnings, as recorded by ASCS, were $605.9 million from April 1977 through September 1980.

Period	Storage earnings	Advance storage payments
	-------(millions)	-------
Apr. 1977 - Sept. 1977	$ 0.4	$ 0.4
Oct. 1977 - Sept. 1978	86.3	215.9
Oct. 1978 - Sept. 1979	282.4	247.3
Oct. 1979 - Sept. 1980	236.8	254.4
Total	605.9	718.0
Outstanding advances, Sept. 1980	112.1	-
Total	$718.0	$718.0

Waived interest on FOR loans is another cost of the FOR. In early 1978 USDA announced that interest charges would be waived after the first year of all grain loans. To offset the impact of the Russian grain embargo, USDA waived the first year's interest on corn entering the FOR between October 22, 1979, and August 24, 1980. Also, the Agricultural Act of 1980 required the waiver of all interest on 1980 and 1981 crop FOR loans.

We were not able to compute the total amount of interest that has been waived because data on individual loans was not readily available. However, we estimate that the total amount might be high. For example, as of June 1979, USDA estimated that the total amount of interest waived on wheat placed in the FOR from October 1977 to the end of May 1978 (335.1 million bushels) at nearly $17 million. Also, we calculated that about $20.1 million in interest was waived on corn that entered the FOR on and after January 7, 1980, until it was released on August 29, 1980.

ASCS administrative costs relating to the FOR include the cost of such activities as processing loan documents and monitoring grain quality. ASCS estimated that from April 1977 through September 1979 these costs totaled about $13.2 million.

Offset against the FOR costs would be FOR loan interest income and any reduction in deficiency payments resulting from any grain price increases due to the FOR. The Government earns interest income when FOR loans are repaid. The amount of interest earned on FOR loans was not readily available from ASCS records.

Deficiency payments are made to eligible producers when the national weighted average market price received by producers is below the target price during the first 5 months of the marketing year. The payment is the difference between the established target price and the higher of the 5-month national average price received by producers or the national loan level. (The target price represents the Government price guarantee that eligible producers must receive for that proportion of their crops covered by the program.) Deficiency payments were made for barley, grain sorghum, and wheat in marketing year 1977; barley, grain sorghum, corn, and wheat in marketing year 1978; and barley and grain sorghum in marketing year 1979. The amount of the deficiency payment would be affected by any increases or decreases in grain prices caused by the FOR.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our primary objective in making this study was to determine the effectiveness of the FOR program since its inception in early 1977. The following issues were addressed:

--The impact on grain stock levels.

--The impact on grain prices, consumer prices, and the meat industry.

--Reserve program mechanisms.

--Reserve grain quality.

--Storage payments.

We reviewed the legislation, regulations, and procedures relating to the FOR program. We interviewed USDA officials from ASCS; ESS; AMS; the Federal Grain Inspection Service (FGIS); the Science and Education Administration (SEA); and the Office of Inspector General (OIG), as well as State and county office personnel.

We performed detailed fieldwork at the Minnesota State ASCS office and the following county ASCS offices:

Crawford and Poweshiek Counties, Iowa

Freeborn and Marshall Counties, Minnesota

Dodge County, Wisconsin

As of July 1980, about 40 percent of the FOR grain was located in Iowa, Minnesota, and Wisconsin.

We also discussed the FOR's impact and effectiveness, problems encountered with the FOR, and possible solutions with academic professionals knowledgeable of the various farm programs and representatives of the grain trade and farm organizations.

The primary work of evaluating the FOR's effectiveness and impact on grain prices, stocks, consumer prices, and the meat industry was done by two consultants with expertise in agricultural economics, grain stocks, and grain reserve policy:

Dr. Bruce L. Gardner
Professor of Agricultural Economics
Texas A&M University

Dr. Richard E. Just
Professor of Agricultural and Resource Economics
University of California, Berkeley

Gardner, through the use of regression analysis, analyzed the FOR's impact on grain prices and grain stocks. Just, through the use of an econometric model, analyzed the FOR's impact on grain prices, consumer prices, and the meat-producing sector of the economy. The consultants' report drafts were critically reviewed by a peer group consisting of three agricultural economists and an applied social scientist with a background in modeling techniques. The consultants considered the peer group reviewers' comments in finalizing their reports. (See vols. 2 and 3.) The reviewers cautioned that due to the short time the FOR has been in effect, any conclusions reached should be considered tentative.

We reviewed procedures used and results of ASCS' special quality checks of FOR grain stored on farm to determine if the quality of this grain was being maintained and to determine the effect of storage on quality. We also considered the results of a March 1980 OIG audit report which included a discussion of FOR grain quality in the Midwest.

We estimated average onfarm storage costs to determine their relation to storage payments made to producers. We obtained a random sample of 154 storage facility loans out of 53,669 loans made nationwide during fiscal year 1979 for use in our analysis to estimate the average onfarm storage cost. (See p. 42.)

CHAPTER 2

THE FARMER-OWNED RESERVE HAS PARTIALLY MET ITS OBJECTIVES

The Food and Agriculture Act of 1977's stated objective for the FOR is to provide a means whereby producers can store grains when they are in abundant supply to extend the time needed for their orderly marketing. More specific objectives, according to USDA officials and publications, are to

--increase grain inventories in times of abundant supply, thereby assuring an adequate supply for domestic and export purposes;

--remove the Government from the role of owning significant stocks of grain for price stabilization purposes; and

--reduce the frequency and/or degree of grain price fluctuations, thus protecting consumers from high prices and producers from low prices.

Our consultants' analyses of the FOR's results in marketing years 1977-79 show that it has only partially met its objectives. Carryover grain inventories were only increased about 1 bushel for every 4 bushels added to the FOR because most of the FOR grain would have been held by private stocks without the FOR. The Government did not own significant grain inventories until the Russian grain embargo, but then the administration purchased grain in an effort to stabilize prices. The Government now has an inventory of corn and wheat which can affect the marketplace. The degree of price stability attributable to the FOR is minor, according to our consultants' analyses, and the net FOR effect in the first 3 years of operation may have been a net economic loss for the U.S. economy as a whole.

These results are based on 2 to 3 years of FOR history; the FOR may need a longer time to prove itself. However, to improve its effectiveness, modifications should be made to provide for methodical adjustments in program operations. (See pp. 17 to 22 and 24.)

LITTLE EFFECT ON INVENTORY LEVELS

One FOR objective is to increase nationwide grain inventories in times of abundant supply. The program should encourage producers to store grain in years of excess supply and thus add to carryover inventories. However, our consultants' analyses show that the amount of grain added to inventories was less than the amount of grain entering the FOR. This is because FOR stocks in large part replaced private stockholding.

Gardner's analysis of FOR program results through marketing year 1979, using annual data comparing ending inventories of corn and wheat in marketing years 1977-79 with those in the pre-FOR years 1972-76, showed no apparent increase in ending inventories in the FOR years. However, regression estimates using annual data since 1950 suggested that the FOR may have added 1 bushel of wheat to total inventories for each 4 bushels in the FOR and 1 bushel of corn to total inventories for each 3 bushels in the FOR. An analysis using quarterly data estimated an even smaller effect. According to Gardner, the quarterly data indicated that for corn and wheat jointly, it takes 5 bushels in the FOR to add 1 bushel to total inventories. Gardner concluded that the most optimistic estimate that was plausibly consistent with the annual and quarterly data he analyzed was that 4 bushels of either wheat or corn need to be added to the FOR to add 1 bushel to total carryover inventories. Thus, when the FOR holds 1.2 billion bushels of grain, 300 million bushels have been added to total grain inventories.

According to Gardner, possible reasons for the limited impact include the following:

--Some producers may use the FOR as a within-year marketing tool. ASCS allows producers to replace grain in storage with newly harvested grain. Thus, some producers may take their grain out of storage to feed or sell just before harvest and replace it with newly harvested grain within 30 days. Therefore, the FOR would have little effect on yearend inventories.

--The incentive value to producers of FOR subsidy payments may be less than the size of the payments would indicate. The net expected gain from participation may not have been much greater than for storage outside the FOR because producers must agree to hold grain for 3 years, unless the release price is reached, and producers would benefit from the FOR's market price-support effects whether they participate or not.

--The FOR quantity ceiling may have discouraged additional storage. In the case of FOR wheat, the 1977 act set the limit below the quantity that likely would have been held if the FOR did not exist. This ceiling could have discouraged storage by lowering profit expectations. Thus, storage payments were not likely to induce large net additions to stocks.

Just's analysis showed a similar FOR impact on grain inventories. He found that over 80 percent of FOR wheat and over 50 percent of FOR corn would be held in absence of Government payments for storage. Because most of the grain entering the FOR would have been held privately without the FOR, costs such as storage payments and waived interest on the loans have been incurred for a minimal increase in carryover inventory.

GRAIN OWNERSHIP HAS REMAINED WITH THE PRODUCER, EXCEPT FOR GRAIN PURCHASED AS A RESULT OF THE RUSSIAN GRAIN EMBARGO

During the initial years of FOR operation, producers retained ownership of the reserve grain with the Government playing a minimal role in grain ownership. However, as a result of actions taken to counter the Russian grain embargo, the Government purchased a significant quantity of grain which could influence future market actions. In the 1960's and early 1970's, the Government owned large quantities of grain. However, in the mid-1970's, these inventories decreased. The average ending Government inventory of corn, wheat, barley, oats, and sorghum for 1974-79 was about 73 million bushels. At the end of fiscal year 1979, the Government owned 199 million bushels of the five grains.

When the FOR was implemented, the proposed method of FOR operation seemed to assure that the Government would not be a significant storer of reserve grain. It would procure grain sufficient to carry on its normal activities of domestic and foreign donations and sales. Some of this grain would be obtained through forfeitures of collateral pledged for commodity loans.

Under the FOR program, producers were to retain ownership and control of the grain and, within program constraints, decide how much to sell and at what price. They could thereby gain from any price increase resulting from the program.

Grain producer association officials told us that producers generally favor a farmer-owned reserve in contrast to Government ownership of stocks and also favor participating in marketing decisions. One agricultural economist told us that previous programs suffered because CCC was not always a knowledgeable trader. Another agricultural economist said that previous programs accumulated quantities of Government-owned grain which hung over the market and depressed prices.

A number of grain buyers and sellers also told us that farmer ownership is preferable to Government ownership of grain stocks. Officials of two major market boards of trade said that, although they opposed any Government disruption of the free market, an advantage of the FOR is that farmers retain ownership and make their own marketing decisions. A grain firm official said that the idea of the farmer-owned, Government-financed reserve was far superior to past reserve programs.

As a result of the January 1980 Russian grain embargo, about 4 million metric tons (about 156 million bushels) of wheat and about 9 million metric tons (about 352 million bushels) of corn were diverted from export. The administration chose to take whatever action was necessary to protect producers from negative embargo price effects. Part of this effort was to encourage increased FOR participation by such actions as waiving first-year interest on FOR corn loans and allowing corn producers, who had not complied with 1979 crop set-aside requirements, to enter the FOR. When this plan did not prove successful, CCC purchased about 154.8 million bushels of wheat and about 159.8 million bushels of corn which had been destined for delivery to Russia.

USDA announced in January 1980 that some of the wheat CCC purchased would be held for the proposed Food Security Reserve for which authorizing legislation was pending in the Congress. 1/ In contrast, CCC will hold the corn for disposal through commercial grain channels. It will not be sold, however, until the price of corn reaches 105 percent of the most recent FOR call price for corn. This corn adds significantly to the Government inventory and will affect the commercial grain market.

LITTLE REDUCTION IN PRICE VARIABILITY

Our consultants found that the FOR's effect on price variability was minimal.

Gardner's analysis

Gardner states that 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 marketplace. He estimated that the FOR's effect in promoting long-term price stability may be significant but is costly and that the effect on short-term price stability has, in marketing years 1977-79, been minimal.

Gardner said that long-term price stability effects are limited by the quantity of carryover grain inventories generated by the FOR. Assuming an average inventory increase due to the FOR of about 200 million bushels over a period of years, Gardner estimated potential long-term stabilization benefits to consumers and producers jointly to be roughly $75 million annually. The corresponding governmental subsidy costs, including storage payments, low interest rates, and waived interest on loans, were estimated by Gardner to be $300 million or more annually.

To test the FOR's effect on short-term price variability, Gardner analyzed price behavior using quarterly and daily data for the pre-FOR period and the FOR's first 3 years. On the basis of this analysis, he concluded that the FOR's effect on short-term price stability has been negligible. He further stated that the

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1/Public Law 96-494, dated Dec. 3, 1980, provides for establishing a U.S. food security wheat reserve of up to 4 million metric tons. This is to be used solely for emergency food needs in developing countries during periods of tight supplies and high prices in the United States or in case of a major disaster.

program thus far may have destabilized prices. This conclusion is based on the finding that grain markets were not more stable in the FOR period than in the years immediately preceding the FOR. In particular, prices rose as sharply following the Soviet grain shortage of 1979 as they had in 1975, even though inventories were significantly greater in 1979 than in 1975. Theoretically, the existence of larger inventories in 1979 should have moderated price movements in 1979 compared with 1975, even without an FOR program.

Gardner's analyses of ending inventory and price data for the 1977 and 1978 marketing years estimated that the FOR had at most a small effect on wheat or corn prices during the period. His statistical analysis of quarterly and annual prices revealed no significant effects, but the possibility of a small effect is implied by the finding that the FOR program may have had an effect on carryover inventories. In its first 2 years, the FOR accumulated grain at a rate of about one-half billion bushels a year. Thus, using earlier inventory estimates (that is, only 1 of every 4 bushels in the FOR represented an addition to total inventories), total inventory accumulation would have increased by 125 million bushels each year. The price effect of removing this quantity from the market depends on the elasticity of demand for U.S. grains. Gardner estimated that for each 1-percent reduction in marketable grain, price increases no more than 4 percent. Because 125 million bushels is about 1 percent of use in domestic consumption and exports, the price effect is unlikely to have been more than 4 percent. A 4-percent increase in corn and wheat prices amounts to about $1 billion annually in increased market receipts to grain producers during the 1977 and 1978 crop years, but this is in part offset by reduced deficiency payments. The gains to producers are offset by increased costs to consumers.

Just's analysis

Just concluded that price stabilization in both the grain and livestock markets due to the FOR was minor. The benefits from short-term stabilization were not sufficient to outweigh the related economic costs. As a result, the program led to a net economic loss over the 2-year period of the study considering all affected market groups. Just concluded that while long-term stability would have greater benefits, long-term stability does not appear to have been an important objective of U.S. agricultural policy. With frequent changes in policy controls, which cannot be anticipated as far in advance as some investment decisions must be made, planning and investment efficiency is lost in agricultural production.

Just's grain market analysis showed that grain producers benefited early in the FOR program, but resulting maladjustment led to a net negative effect. As producers accumulated FOR stock in the program's first year, the program acted as a price support. This early upward price effect caused estimated real income to be higher for wheat and corn producers than it would have been with no FOR and caused grain producers to increase production over what it otherwise would have been. However, due to increased demand associated with accumulating the FOR, feed prices were temporarily higher than they would have been without the FOR. This caused contraction in the livestock industry from what it would have been.

When the FOR grain was accumulated and the grain market could have returned to normal, the demand for feed was lower because the livestock industry had held back on production. Thus, grain prices were then lower than they would have been. This led to a subsequent decline in short-run profits for wheat and corn producers compared with the non-FOR case. These effects of the FOR took some time to wear off because of the long time lag required to change herd sizes and produce feeder animals.

Conversely, Just's analysis showed that grain consumers, feeders, private (non-FOR) storers, and importers were adversely affected by the initial price increases but then benefited from the later lower prices compared with a situation with no FOR. The analysis showed that for consumers, stockholders, and importers, the adverse effects during the 1977 crop year were more than outweighed by the beneficial effects during the 1978 crop year, with consumers benefiting the most.

Just's livestock industry analysis showed that during the 2 years analyzed, the livestock market participants suffered a net loss. This loss was caused in part by the early false price signals which caused the livestock industry to hold back on production. As noted above, recovery was slow because of the long time lag required to change herd sizes and produce feeder animals.

In the case of consumers, meat prices were higher than they would have been without the FOR. The related consumer losses were due to the initial slackening tendency of meat supply under the FOR, which was in part a result of the false grain price signals in 1977. The higher corn prices in the first three quarters of 1978 caused a reduction in investment in herd expansion and cattle placed on feed. These pressures were then reversed in mid- to late 1978 as the accumulation of FOR stocks slowed down. This reversal led to subsequent expansionary incentives for the livestock industry compared with the non-FOR case, the fruits of which began to come to market in mid-1979.

Just's analysis also showed that the upward pressure on livestock prices shortly after the FOR program was introduced led to increased livestock producer short-run profits which outweighed meat consumer losses. However, adverse effects of high prices on meat consumers caused net effects to turn negative in the first quarter of 1979. Then, as greater meat supplies became available in response to downward FOR grain price pressures beginning in 1978, the beef price effects of the FOR turned negative and led to producer losses which dominated the related consumer benefits (relative to the case with no FOR).

These results suggest that substantial periods of adjustment may be required by the livestock industry when grain policies are changed. Furthermore, some of the related economic losses suffered because of inability to plan herd expansion or contraction effectively can be substantial.

According to Just's analysis, the overall effects on incomes in the first 2 years of the FOR program were large, with net economic losses as high as $4.4 billion for grain and livestock market participants combined. The net livestock industry loss, which made up $0.2 billion of the overall loss for the first 2 years, has probably increased since the period of analysis because the industry was still in a process of substantial adjustment in mid-1979.

Because these estimates relate only to the first 2 years under the FOR, it is possible that subsequent activity could result in overall net gains for the grain and livestock sectors jointly. However, with major modifications in program controls and methods for altering controls (see pp. 17 to 22), the effects of which could be better anticipated by producers in making decisions that affect later supplies, much of the losses of the type incurred thus far could be avoided in future reserve policy.

USDA STUDY OF FARMER-OWNED RESERVE IMPACT

A USDA study of the FOR wheat program entitled "Impact of Farmer-Owned Wheat Reserve on Total Wheat Stocks and Prices," released in April 1980, indicated that during the 1977-78 and 1978-79 marketing years, the wheat FOR provided a substantial additional demand for wheat. According to the report, each bushel of wheat added to the FOR contributed from 0.40 to 0.87 bushel to total inventories.

Assuming the 0.87-bushel contribution, the report estimated that the FOR increased wheat prices 8 cents in 1977-78 and 54 cents in 1978-79 over what the prices would have been with no FOR. The report concluded that under these circumstances, the FOR increased the value of wheat sold by producers by $1,265 million, of which $865 million would have been offset by reduced deficiency payments.

Assuming the 0.40-bushel contribution, the report estimated that the FOR increased wheat prices 8 cents in 1977-78 and 20 cents in 1978-79 over what the prices would have been with no FOR. In this case, the FOR would have increased the value of wheat sold by producers by $568 million, of which $410 million would have been offset by reduced deficiency payments.

The report emphasized that the data base used for estimations was small and many subjective market behavior conditions were imposed on the model; thus, pinpoint accuracy was not suggested. In addition, the study did not consider the interaction with other markets, such as the feed grain and livestock markets.

As noted earlier, our consultants' analyses of the FOR concluded that for each bushel of grain placed in the FOR, from 0.2 to 0.5 bushels were added to total grain stocks. Thus, the studies agree that the FOR's impact was less than 1 bushel added to total grain stock for each bushel placed in the FOR.

POSSIBLE FUTURE ACTIONS TO IMPROVE PROGRAM EFFECTIVENESS

Considering that the FOR, as currently structured, has not fully met its objectives, what can be done to improve the effectiveness of future grain management practices? The following alternatives could be considered:

--Retain the FOR concept, but with modifications.

--Discontinue the FOR, but continue CCC price-support loans and storage facility loans.

--Discontinue the FOR and pay producers a subsidy on carryover grain stocks.

--Discontinue the FOR and return to CCC storage.

--Discontinue the FOR, keep the CCC price-support loan rate low, and rely on unsubsidized private storage with no public inventory.

Retain FOR concept with modifications

This option would retain the essential features of the FOR (that is, producer ownership, loans, trigger prices, and storage payments) but change certain aspects. According to officials of grain-producer associations, the concept of producer ownership of the grain--in contrast to Government ownership--is popular with producers. By retaining ownership, producers can make the marketing decisions--within program constraints. Thus, this alternative may have the strongest popular appeal.

Certain aspects of the program, however, could be modified. Some possible modifications include (1) removing FOR quantity limits, (2) emphasizing long-term rather than short-term stabilization, (3) establishing methodical rules for adjusting loan rates and release and call levels, (4) allowing grain merchants, millers, exporters, and other middlemen to participate in the program, (5) ensuring that FOR grain is actually stored from one crop year to the next, and (6) changing release and call levels relative to loan rates.

Remove FOR quantity limits

Gardner suggests that removing the upper limits on the FOR should encourage the holding of private stocks outside the FOR in low-price years because the probability of a further price decline is reduced by the absence of a limit. Thus, increases in total stockholding could be encouraged. A negative aspect of removing the quantity limit might be that Government program management flexibility would be lost if producers chose to place too much grain in the FOR.

Emphasize long-term stabilization

The FOR has been operated with close attention to short-term price fluctuations--release and call decisions are based on a 5-day moving average. Yet, according to Gardner, price stabilization of most value to consumers, producers, and the economy generally occurs on a longer term basis.

Gardner's analysis showed that while smoothing out short-term, intraseasonal price moves would be beneficial, no indication could be found that the FOR had been effective in such short-term stabilization; in fact, indications were that the program moves had had a destabilizing effect. He suggests that fundamental supply/demand changes would seldom occur more than once within a crop year. These instances may be cases such as a Southern Hemisphere crop failure or a serious international crisis.

Thus, Gardner suggests that USDA focus on the program over the long term. One possibility he discussed would be to base program decisions on a several-month moving average within the crop year, after an initial decision on the program status for the coming year based on the situation following the first reasonably reliable crop forecasts, such as August 15 of each year. He suggests that this kind of change would remove USDA from the role of short-term manager of the U.S. grain markets and keep the program from being hampered by reactions to short-term State and regional price fluctuations due to situations such as transportation tie-ups, storage capacity crises, and strikes.

Establish methodical program adjustment rules

Just emphasizes the need for some type of self-adjusting policy that could be anticipated by producers and would provide for orderly program changes. Gardner also suggests that future adjustments in support, release, and call prices be made according to a published and stable rule.

In addition to agricultural policy changes every 4 years, developments have led to a number of within-year FOR program revisions. From the point of view of grain and livestock producers, these changes were unpredictable and thus made management decisions difficult because the producers had to react to the changes after they were announced. Just's analysis indicates that the costs of these changes can be substantial.

Except in the case of the Russian grain embargo, when the FOR approached quantity limits, the policy has been to consider set-aside controls to avoid further reserve accumulation. Just suggests that, if set-asides are to continue, perhaps the set-aside level should be keyed to the level of accumulated reserves. For example, for every 20 million bushels of wheat in the FOR, a 1-percent set-aside could be required. Thus, producers could anticipate set-aside requirements quite closely and thereby avoid the present situation where, for example, there is either no set-aside or a 20 percent set-aside.

In addition, several changes have occurred piecemeal in loan rates, release levels, and call levels, apparently to correct inadequacies in the program. Producers were unable to anticipate the type and timing of such events and thus could not build these changes into their plans. While such uncertainties create a management problem for grain producers, they could create an even greater problem for livestock producers because of the longer production time lag.

Changes such as those mentioned above will likely continue to be necessary when specific levels of support are determined only after existing levels appear too far out of line. Just suggests that a better approach would be to change loan rates more frequently in smaller amounts in accordance with observed and anticipated changes in price levels. However, he suggests an even better approach would be to specify in advance how the loan rates and release and call levels would be changed in response to market conditions. These observed market conditions could include producer income levels, inflation of food prices, the size of Government-related stocks, and Government costs. Loan rates supposedly avoid low farm incomes, and release and call levels avoid rapid food price inflation. Yet, acceptable levels of farm income and consumer prices change with inflation. Just therefore suggests that the loan rates and release and call levels might be keyed to inflation. Gardner suggests that adjustments for changes in the general price level might be made by increasing all release and call levels and loan rates annually by the same percentage as the general price-level increase.

Just suggests that price incentives may be necessary to avoid reserve depletion. Thus, loan rates may need to be increased when reserves become low. To accomplish this goal methodically, Just suggests that the loan rate could be tied to the level of reserve accumulation as well as to inflation. For example, the loan rate could be increased 1 cent a bushel for every 3 million bushels the reserve is below some target level. This would allow producers to anticipate the loan rate changes.

Another self-adjustment mechanism suggested by Just involves the storage subsidy. Rather than having the "all or nothing" storage payment tied to a specific price level as it has been, subsidies could be offered on a partial and sliding basis. This type of program is suggested in lieu of the present loan rates, release levels, and call levels and is a generalized version of the type of program suggested by a USDA agricultural economist. (See p. 22.) For example, producers could be paid a storage subsidy of a specified amount per bushel, say 25 cents, plus 10 percent of the difference between a target price and the current price. This would encourage storage when prices are low and vice versa. This sliding scale for storage subsidies would be announced well in advance so producers could anticipate rate changes.

To avoid the need for continual, unanticipated, year-to-year revisions in the storage subsidy rule, Just suggests that the target subsidy should be specified to depend on the FOR's accumulated yearend size. For example, the target subsidy could be determined by subtracting 5 cents a bushel for each million tons by which the FOR exceeds its desired level.

These suggested changes attempt to provide for orderly and definite adjustments. Producers would be able to anticipate such changes well in advance and plan accordingly. Being able to anticipate changes years in advance is important because many investment decisions affect production for years to come.

Allow nonproducers to participate

A modification that Gardner suggested for study is to allow grain merchants, millers, exporters, and other middlemen to participate in the program. He suggests that this modification might increase the FOR's ability to add to total grain inventories and reduce the social cost of storing the additional grain. It would allow nonproducers to expand their stocks at costs that in some cases may be lower than producers' storage costs. He argues that these merchants, exporters, millers, and other middlemen would be encouraged to hold stocks when expected price gains exceed storage costs. Under the current FOR program, the storage payment induced producers to increase their grain stocks above the levels they would have held in the absence of the FOR.

Gardner cites three objections to making nonproducers eligible for the FOR. First, some subsidies would be paid to nonproducers, as they currently are to producers, for storage of grain that would have been stored in the FOR's absence. Second, the quantity of nonproducer-owned grain stocks was quite small even before the FOR went into effect. Thus, making payments to nonproducers would be unlikely to make a large difference in total stocks. Third, it would be turning over some of the control and profit from grain carryover storage, currently in the producers' hands, to nonproducers. Gardner states, however, that while these objections must be taken seriously, they should give way if, in the interest of improving the FOR as a long-term stabilization program, making nonproducers eligible can achieve any significant increase in stockholding.

Ensure storage from year to year

As mentioned earlier (see p. 11), one of the reasons Gardner gives for limited FOR impact on ending grain inventories is that producers who are short of storage space at harvest time can, if authorized by ASCS, sell old-crop reserve grain and not replace it with new-crop grain for up to 30 days. Also, any unauthorized switching of new-crop for old-crop FOR grain at harvest would have the same impact. Producers in effect can use the FOR as a within-year marketing tool, participating in the program year after year without ever adding a bushel to carryover stocks. Eliminating these practices, except where necessary (that is, to replace out-of-condition grain), would assure that old-crop grain is carried into the new-crop year.

Disadvantages of this proposal include the additional ASCS surveillance cost, especially to watch for unauthorized sale and replacement, and the uncertainty as to the degree to which such sale and replacement is occurring. Nonetheless, according to Gardner, these practices should be eliminated if the FOR program is to be truly effective in increasing carryover stocks.

Increase release and call levels relative to loan rates

Gardner states that the FOR program reduces the probability of observing prices above the release price but increases the probability of prices rising up to and just below the release price. His analysis showed that during the FOR period, prices tended to be at or near the loan rate or else at or near the release price, as compared with intermediate levels. This instability could be reduced by narrowing the distance between the loan rate and the release price. However, if this distance is too narrow, private speculative storage outside the FOR is discouraged. Also, it may encourage producers to sell grain at relatively low prices and thus do little to promote stockholding. Grain stocks then may not be available when needed. If the release level is too high (maybe twice the loan rate), the instability mentioned above is created. Current levels are set somewhere between, so the program provides some of the drawbacks of each. However, not enough is known about the price reactions to high or low release prices or the frequency or social costs of future severe shortages to make a scientific choice possible.

Discontinue FOR but continue price-support and storage facility loans

The FOR could be discontinued while retaining the price-support and storage facility loan programs. In his analysis, Gardner suggests that the storage facility loan program concentrates its subsidies on reducing costs of storage at the margin and does not discourage private stockholding. For market stabilization purposes, the program would rely on private storage for carryover stocks. The CCC loan program would continue at a low support level for loan periods of less than a year. Grain acquired by CCC should be placed back on the market at prices relatively near the loan rate to avoid holding CCC stocks for long periods.

To assure availability of stocks to combat extreme shortages, there would be a limited amount of Government-held emergency stock. Gardner suggested possibly 5 million to 6 million metric tons of corn and wheat. Any sale of this stock would occur only when prices are well above the price expected to prevail under average conditions, so its impact on privately held storage would be minimized.

Discontinue FOR and pay an unrestricted subsidy

A USDA agricultural economist has suggested replacing the FOR with a farmer reserve subsidy. 1/ Under that program, producers would be eligible for a storage subsidy on grain they grew and held until the last day of the marketing year. USDA would announce the subsidy amount before the first day of the marketing year so it could be incorporated into everyone's marketing decisions. A possible alternative strategy to paying a lump sum grain subsidy would be to pay an equivalent subsidy per day until the grain is sold.

Under the subsidy system, only producers would be eligible for the subsidy and they would retain ownership of the grain. The system would also eliminate release and call procedures and producers themselves could decide when to sell.

The study approach assumed that (1) social benefits are derived from yearend stocks not captured by the market, (2) the political decision has been made that the bulk of the grain held in reserve should be under producer ownership, and (3) the criterion for measuring the program's performance is its impact on potential grain price variation. It was also assumed that a small, ongoing CCC program would exist under which the Government would hold some grain. The author noted that the success would depend on the public's belief that it is protected from grain shortages with a producer-held grain reserve over which the Government would have little control.

1/Jerry A. Sharples, "An Alternative Farmer Reserve Program," USDA-ESCS, Apr. 1979.

Gardner points out that an argument against a simple subsidy is that producers may respond to price changes irrationally and not sell when they should sell. However, he sees no evidence that the producers' judgment would be any better or worse than that of USDA if stock were held by the Government.

Discontinue FOR and return to CCC storage

Just suggests that Government ownership of stock might be considered and that if the rules of buying and selling Government-owned grain were announced in advance, decisionmakers could incorporate such anticipated actions into their plans. He suggests that one way of avoiding too large an inventory, and thus cost, would be to operate the controls according to a prespecified scale. For example, rather than offer to buy all grain at the loan rate, the Government would offer to buy 1 million bushels of grain for every 1 cent a bushel the market price is below the target price (and no deficiency payments would be paid). In contrast, it would sell 1 million bushels for each 1 cent a bushel the market price is above the target price. The market price used in these transactions should be some type of moving average price that would not be based on day-to-day random market fluctuations but perhaps on week-to-week or month-to-month price fluctuations.

In addition, a rule should be specified for modifying the target price. The modification could be based on the level of Government stocks relative to some Government stock goal. For example, if the long-term goal were 400 million bushels, the target price could be increased for each succeeding year by maybe 1 cent for every 3 million bushels the Government stock is below 400 million bushels.

According to Just, Government ownership of stocks has been unpopular because of the influence it places in the hands of a few individuals making Government buy/sell decisions. The changes discussed above, according to Just, should avoid those problems because Government buy/sell decisions would be controlled by a prespecified formula.

Free market system with low support prices

This alternative would involve discontinuing the FOR, retaining a low loan rate, and relying on unsubsidized private storage for price stabilization with no public stocks of any kind. Gardner states that this "free market" approach would eliminate substantial governmental costs and would probably not increase price instability, compared with the FOR, as much as might be expected. According to Gardner, the 1975-77 pre-FOR period does not look bad when compared with the FOR experience. Gardner also states that forward contracting and futures, options, and insurance markets may over the long term provide mechanisms for stabilizing producers' returns and grain users' costs more efficiently than subsidized storage or other interventions in the grain markets.

However, it could be argued that under the conditions of this alternative, too little grain would be stockpiled. Also, deregulation of the grain markets may be too extreme an action at this time.

CONCLUSIONS

The FOR has only partially met its objectives based on analyses of the first 2 to 3 years of operation.

--The FOR has not added nearly as much to total grain inventories as the FOR quantities would indicate. Most grain that the FOR has attracted would have been stored by producers if the FOR did not exist.

--While the FOR initially succeeded in ensuring producer ownership of reserve stocks, the Government now holds grain purchased in response to the Russian grain embargo.

--The degree of price stability attributable to the FOR has been minor.

--The net FOR effect may have been an economic loss for the U.S. economy as a whole.

The FOR has been in operation only a relatively short time and not long enough to be adequately tested. However, modifications should be made to provide for methodical adjustments in program operations. Other possible modifications discussed in this chapter require further study before implementation is considered.

RECOMMENDATIONS TO THE
SECRETARY OF AGRICULTURE

We recommend that the Secretary provide for methodical program adjustments in response to a broad range of potential market and political developments to allow decisionmakers in grain and related industries to anticipate such changes and adjustments, while still allowing for some necessary flexibility. We also recommend that the Secretary study the feasibility of other FOR program modifications discussed above and, if they provide remedies to the problems we found, incorporate them into the program. In addition, we recommend that the Secretary evaluate the FOR's effectiveness to serve as a basis for the Congress to use in making future grain policy decisions.

AGENCY COMMENTS AND OUR EVALUATION

USDA believes (see app. III) that the FOR program has been relatively successful, recognizing the problems associated with its implementation and other problems such as the Russian grain embargo. It added that a longer period of FOR operation would no doubt provide a stronger basis for more definitive analyses.

USDA said that our consultants' studies reached conflicting conclusions on the FOR's effect on price variability: one reported an increase in price variability in the short run, while the other reported a decrease. It noted that results from other analyses (simulation studies) suggest that an FOR should reduce variability.

Although our consultants' studies showed some minor differences, their conclusions did not conflict. Both concluded that the FOR's effect on price variability was minimal. As to the results of other analyses, USDA says only that they suggest that an FOR should reduce variability, not that the FOR as it has operated has actually done so.

Regarding the impact of the FOR on grain inventories, USDA said that the consultants' studies miss an important point. It said that if the FOR had not existed, these stocks, if held, would have been held primarily by nonproducers and prices would have been sharply lower, thereby contributing to increased year-to-year price and production instability. Our consultants stated there was no evidence to support USDA's contention and that, even if nonproducers held these stocks, they felt there would probably be no impact on price. USDA statistics reveal the portion of all grain stored by producers has not changed materially since the FOR's inception.

Regarding Just's statement that the livestock sector was adversely affected by the FOR, USDA said that given the stage in the cattle cycle and financial market conditions, the problem was caused primarily by lower livestock product prices and high interest rates rather than higher corn prices associated with the FOR. According to Just, factors such as cattle product prices and interest rates were held constant (either implicitly or explicitly) in his analysis, both with and without the FOR, in determining the FOR's effectiveness. Thus, the FOR effects estimated in Just's study represent a situation after these factors are removed.

USDA said that a study based on a longer period and of a different methodological approach (that is, simulation analysis) would provide more insight into the longer run effects. Just notes that simulated analyses, in the way they have been applied thus far, generally use inflexible functional forms. As shown by the theoretical analysis in Just's study (vol. 3, sec. 8), this approach can arbitrarily limit the type of results that can be obtained.

Gardner used a simulated analysis in his study (vol. 2, sec. 7) where, using certain assumptions, he found that the potential long-term stabilization benefits of the FOR to consumers and producers jointly to be roughly $75 million annually. He pointed out, however, that several caveats had to be kept in mind about this estimate. Among these caveats was that the values of supply and demand elasticities and the estimated reduction in price variance caused by the FOR, to which the estimated gain is sensitive, are not known with precision.

USDA said that the FOR enhanced producers' income in surplus production years and provided confidence to domestic and foreign markets during short crop years. Our consultants did not find that producers' income had been enhanced, and they stated that production and price had not varied enough in the FOR years studied to support USDA's statement.

USDA agreed with our recommendation that the program be modified to provide for methodical adjustments in program operations while still allowing for some necessary flexibility. It said that numerous changes had been made to simplify the program, to reduce the need to make changes, and to make the program better serve producers and consumers. It said that it intended to continue these efforts.

On other possible program modifications (see pp. 18 to 22), USDA said that it had some reservations regarding the removal of FOR quantity limits and allowing nonproducers to participate. It said, however, that these possible modifications would be examined as the FOR is reviewed in relation to other policy instruments. It said that all aspects of the FOR were being reviewed and that it would work with the Congress to provide a workable reserve program that will address the needs of all segments of the farm community and the Nation.

CHAPTER 3

THE FARMER-OWNED RESERVE INCLUDES

SOME GRAIN OF QUESTIONABLE QUALITY

USDA studies show that although most of the farm-stored FOR grain at the times of the studies was of acceptable quality, some was of questionable quality. Questionable-quality grain is grain not suitable for storage due to high moisture, infestation, high kernel damage, contamination, or other conditions that could affect the grain's quality during storage. The studies did not show how much of the questionable-quality grain was of low quality when it entered the FOR and how much had deteriorated while in storage. Incurring storage or other costs, such as waived interest, for questionable-quality grain is not in the Government's best interest.

ASCS should obtain official grade determinations on grain in a sample of bins as they enter the FOR and on that same grain each subsequent year. This sampling would help to develop a profile of FOR grain quality and identify characteristics which are predictors of storability. On the basis of the above study results, as well as those of a Grain Marketing Research Laboratory project, ASCS should make procedural changes, as necessary, to eliminate questionable-quality grain from the FOR. In addition, ASCS needs to (1) require that, at a minimum, all grain be visually inspected immediately before it enters the FOR and (2) follow up in a timely manner on grain with quality problems serving as loan collateral to make sure corrective action is taken.

USDA STUDIES SHOW SOME RESERVE GRAIN TO BE NONSTORABLE

ASCS and OIG studies have shown varying percentages of FOR grain to be nonstorable.

ASCS grain quality studies

ASCS has made four nationwide random checks of farm-stored FOR grain quality. For the checks, ASCS compliance inspectors obtained samples and submitted them to inspection agencies, designated by FGIS, for official grade determinations. The respective dates and the commodities sampled are as follows.

Random check	Sample selected as of	Commodities sampled
1	Nov. 9, 1978	Barley, corn, oats, sorghum, wheat
2	Sept. 30, 1979	Barley, corn, oats, sorghum, wheat
3	May 23, 1980	Wheat, oats
4	Aug. 22, 1980	Corn

1978 and 1979 quality checks

For the 1978 and 1979 checks, ASCS projected the results to the total grain in the FOR as of the respective sampling dates. Grain that was musty, sour, distinctly low quality, heat damaged, and/or had high moisture was considered to be nonstorable. An ASCS official acknowledged that the definition of nonstorable was broad and included some storable grain, such as heat-damaged kernels from artificially drying grain at too high a temperature or grain that was once nonstorable but conditioned and made storable again.

ASCS projected the results of its 1978 statistically valid random sample and found that as much as 33.4 million bushels--or 5.4 percent of the total grain in the FOR--contained nonstorable grain. This amount included 4.1 percent of the wheat and 6.6 percent of the corn. 1/ ASCS concluded that, in general, grain in the FOR was good and that good storage management by producers and monitoring by county offices could greatly minimize poor grain quality and storability problems.

ASCS' projections on its 1979 check showed that as much as 94 million bushels serving as loan collateral--or 12.8 percent of the total grain in the FOR--contained nonstorable grain. In addition, as much as 37.2 million bushels were insect-infested. Although ASCS was concerned about the storability of infested grain, it did not consider infested grain to be nonstorable. An ASCS official said experience has shown that insects can be controlled with fumigation. ASCS concluded that the percentages of storable barley, oats, and wheat (90.1, 95.8, and 92.8 percent, respectively) were generally good and that corn and sorghum (83.9 and 80.0 percent storable, respectively) had higher rates of nonstorable and infested grain. The results of the 1978 and 1979 checks are shown in more detail in appendix II.

1980 quality checks

The final results of ASCS' analyses of its 1980 checks were not available as of December 9, 1980. However, some pre-

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1/For purposes of projecting the results of the 1978 and 1979 quality checks to the total FOR, ASCS considered all the grain in a bin nonstorable if the official grade of the sample drawn met its definition of nonstorable. On this basis, the percentages may be overstated. The procedure followed would result in accurate projections to the degree that samples drawn were representative of the grain in the bin. Because some compliance inspectors used equipment that was not long enough to sample grain from the bottom of the bin, some samples contained a disproportionate amount of surface grain. It is not uncommon for surface grain to be deteriorated, but not grain below it, according to USDA officials.

liminary results were available through SEA. (As part of a research project [see p. 37], SEA received and analyzed a portion of all samples ASCS drew for random checks 3 and 4.) A draft SEA situation paper stated:

> "Preliminary data * * * suggest that there is an insect problem in on-farm storage grain. The percentage of the samples found with one or more live insects after incubation are as follows:
>
> | Commodity | No. Samples Examined | Percent Infested |
> |---|---|---|
> | Corn | 2,893 | 65.8 |
> | Oats | 1,051 | 53.3 |
> | Wheat | 4,115 | 23.1" |

SEA incubated the grain samples, providing optimum conditions for insect hatching, which may have contributed to the high percentages. Information on the species and density of the insects in individual bins was still pending.

OIG grain quality study

In March 1980 OIG reported on its review of the quality of FOR corn and wheat in five States. The five States represented about 79 percent of the farm-stored FOR corn and wheat at May 31, 1979. OIG obtained FGIS grade determinations on samples its auditors drew from grain serving as collateral for 220 FOR loans. Grain serving as collateral for 50 of the loans graded U.S. Sample grade, the lowest quality designation under U.S. grain standards. Based on a projection of these results, OIG estimated with 95 percent confidence that at least 44.7 million bushels (6.8 percent) and as much as 91.8 million bushels (13.9 percent) of FOR corn and wheat in the five States would grade U.S. Sample grade. Of the 50 loans for which some grain graded U.S. Sample, 24 were so graded because of conditions caused by storability problems (that is, musty, sour, and/or with a commercially objectionable foreign odor) and 13 because of conditions which caused the grain to be unfit for human consumption (that is, animal filth).

We were not able to compare the OIG and ASCS results statistically because of the differences in the universes of loans sampled, time periods, and seasonal weather conditions. The results of our analysis of OIG data, shown in the following table, seem consistent with ASCS' results. The table shows that OIG classified grain as nonstorable in two ways--as a percent of bushels sampled and as a percent of bins sampled. We believe both are important in evaluating the quality of FOR grain. The percent of bushels indicates the maximum amounts of nonstorable grain; the percent of bins shows the number of problem bins needing corrective action.

Our Analysis of OIG Data on FOR
Corn and Wheat Quality in Five Midwestern States

Commodity and condition	Bushels		Bins	
	Number sampled	Percent	Number sampled	Percent
Corn:				
Storable	1,337,047	94.2	218	94.8
Nonstorable (note a)	82,825	5.8	12	5.2
Total	1,419,872	100.0	230	100.0
Wheat:				
Storable	982,055	97.6	107	89.9
Nonstorable (note a)	24,025	2.4	12	10.1
Total	1,006,080	100.0	119	100.0

a/Grain was musty, sour, and/or had a commercially objectionable foreign odor.

Based on its study results, OIG recommended that ASCS sample all grain at the time it is placed in the reserve and obtain a grade determination so that ineligible grain (that is, grain with excess moisture or grain that is weevily, musty, or sour) can be identified.

Experts' opinions on FOR grain quality

USDA officials, grain traders, and academic professionals knowledgeable about grain quality were unable to tell us what percent of grain stocks might be expected to be nonstorable at any specific time. An official of one firm said that he could not make a definitive statement but felt that the percentages which ASCS and OIG had found were high. Generally, the grain traders said that their level of concern would be based on the degree to which grain was infested or nonstorable. For example, their degree of concern about a musty odor--a grain quality characteristic included in ASCS' definition of nonstorable--would depend on whether the musty odor was weak or strong.

CAUSES OF QUESTIONABLE GRAIN QUALITY

Specific causes of the questionable-quality grain in any individual bin are not readily determinable because ASCS does not obtain official grade determinations on grain when it enters the FOR. We identified two causes of questionable-quality FOR grain--low-quality grain is allowed into the FOR and some FOR grain has deteriorated in storage. Other contributing factors include ASCS' inadequate procedures for identifying loans secured by grain with quality problems and for correcting or eliminating quality problems identified.

Low-quality grain is allowed into the FOR

While the act does not provide guidelines on what qualities of grain are eligible for the FOR, ASCS established minimum standards for farm-stored grain. Prior to the 1980 program, before a loan was approved on farm-stored grain, it had to be determined that the grain was reasonably expected to be stored with safety until maturity of the loan. ASCS amended this requirement for 1980 and subsequent crops. Under the new regulations, farm-stored grain is allowed into the reserve as long as the grain meets the eligibility standards for obtaining a price-support loan. Although the eligibility standards for each type of grain are not necessarily uniform, in general, these standards require that the grain be storable, merchantable, and free from substances poisonous to humans or animals, such as toxin-producing molds or mercurial compounds. In addition to these general standards, these new regulations specifically require that wheat entering the reserve must, be "merchantable for food" and must not grade ergotic, treated, weevily, smutty, or garlicky.

Even with the change, however, some wheat that may not meet the quality standards under the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.) remains eligible. For example, wheat that has a commercially objectionable foreign odor is eligible for the FOR. However, under a memorandum of understanding between FGIS and the Food and Drug Administration (FDA), if FGIS or FGIS licensees sample and inspect a lot of grain and find it has a commercially objectionable foreign odor, they must report it to FDA for possible investigation. We do not believe such questionable-quality grain should be in the FOR.

ASCS county commodity inspectors are to determine whether or not farm-stored grain meets ASCS' standards by visually inspecting the grain. If the inspector questions the eligibility of the commodity, a sample shall be drawn and submitted to FGIS for quality analysis. ASCS has not provided adequate guidelines for making this determination and therefore has no assurance that standards are uniformly applied. In addition, all feed grain entering the FOR and all wheat that entered the FOR before August 1980 did not need to be visually inspected if it had been inspected at the time it was sealed under the price-support loan program and if the county committee had no reason to suspect that grain had been removed or had deteriorated. With the change to a food-quality wheat reserve, ASCS required county compliance inspectors to inspect all wheat immediately before it entered the FOR.

Some FOR grain deteriorated in storage

Some FOR grain has deteriorated because of improper storage management. The reasons other grain is deteriorated are less clear.

ASCS findings on FOR grain quality

We analyzed the reasons ASCS considered some FOR grain to be a problem--based on its 1978 quality check. In Minnesota, ASCS considered 293 of the 1,402 bins it sampled to have problems significant enough to require county office followup. The problems by type of grain are shown in the following table.

Quality problem	Percent	Bins: Total	Barley	Corn	Oats	Wheat
Presence of animal filth	29.7	87	13	1	16	57
Damage	18.8	55	1	36	0	18
Musty	16.0	47	22	7	6	12
Weevily	4.1	12	5	2	0	5
Heating and insects	3.4	10	3	2	1	4
Moisture content too high	2.0	6	4	1	1	0
Distinctly low quality and/or commercially objectionable foreign odor	2.0	6	2	0	4	0
Sour	1.0	3	2	0	0	1
Unsound storage structure	4.4	13	5	1	5	2
Problem not defined	18.4	54	13	20	11	10
Total	a/100.0	293	70	70	44	109

a/Total does not add due to rounding.

The presence of rodent excreta or other animal filth was the most frequent quality problem found. This problem clearly results from improper storage facilities and/or storage management practices. Either the storage facilities had holes large enough for rodents or other animals to enter or the producer left the facility doors or tops open.

The reasons for the other storage problems ASCS noted are less clear. For example, musty and sour odors may stem from mold growth which could be due to either improper storage management and/or inherent qualities of the grain. We were told that grain may mold if a bin is not properly aerated. Poor aeration may be due to such things as the improper use of aeration equipment or grain having high percentages of fine material, weed seeds, and extraneous materials packing together and impairing the air flow.

The USDA officials, grain traders, and academic professionals we talked with had a number of opinions about the quality of farm storage. Sixteen of 21 individuals indicated that onfarm storage in general falls short of optimum conditions because of poor grain management practices and/or inadequate storage structures. Examples of poor management practices included the failure to fumigate and control insects, rotate grain stocks, monitor grain quality, and control moisture. Problems of inadequate storage structures included structures which were not grain tight and lacked aeration equipment.

25 cents a bushel to increase program participation. 1/ These rates were established on bases other than the cost of onfarm storage, which represented the majority of FOR storage.

Storage payments to producers in fiscal year 1979 (at 25 cents a bushel) exceeded estimated average onfarm storage costs by from 3.3 cents to 8.6 cents a bushel depending on whether a storage facility is assumed to have a 10-year or 20-year life. For fiscal year 1979, the excess represented $28 million or $72 million to producers storing FOR grain onfarm. In fiscal year 1979, about 76 percent of the FOR grain was stored on the farm, with the balance in commercial storage space. The average annual rate charged for commercial storage space nationwide was about 26.4 cents a bushel for the period July 1, 1978, through June 30, 1979, and about 26.8 cents for the period July 1, 1979, through June 30, 1980.

We found very few studies containing recent cost data on onfarm storage. The latest study we obtained was a master's thesis completed in 1978 by a Kansas State University graduate student. 2/ The study's purpose was to determine the costs of onfarm storage and drying of grain in Kansas. The study results showed that the estimated average annual cost for onfarm storage ranged from 19.2 cents to 10.7 cents a bushel for the smallest and largest facilities, respectively, based on 100-percent utilization and depreciation of the facilities over 20 years and of the equipment over 10 years. The study showed the average annual storage costs for a 10,000-bushel facility to be 15.8 cents a bushel.

Because of the lack of onfarm storage cost data, we developed estimates of such costs based on a random sample of ASCS' fiscal year 1979 storage facility loans, information from other studies, and discussions with county auditors and insurance agents. On the basis of this information, we conservatively estimated that farm storage payments in fiscal year 1979 were at least 3.3 cents a bushel, or a total of at least $28 million, more than the estimated average onfarm storage costs. We assumed a 10-year useful bin life and no salvage value, whereas the useful bin life could be much longer and some facilities may have residual or salvage values. We also assumed 100-percent utilization. Also, we used fiscal year 1979 facility construction costs, although it is unlikely that all FOR participants stored grain in facilities constructed in 1979 and many therefore may have had lower capital costs.

1/Effective Jan. 7, 1980, the annual storage rate on these grains was raised to 26.5 cents a bushel to offset the effects of the Russian grain embargo. This rate remained in effect at Nov. 30, 1980.

2/Randal L. Linville, "The Economics of Farm Grain Storage and Drying in Kansas," Kansas State University, Manhattan, Kansas, 1978.

In the five counties we reviewed, county office officials generally informed producers of any problems the compliance inspectors found and asked the producers to correct the problem and report back to the county office. Some producers reported back, but not always promptly. However, most did not report back and the county office rarely followed up. Therefore, ASCS had no way of knowing whether corrective action was taken. We found no case where a loan was called because the producer did not correct a problem.

At the three county offices which generally sent letters to producers asking them to take corrective action and report the disposition, we reviewed cases involving 55 producers who were asked to report back to ASCS. As the table below shows, only 24 did so. Also, ASCS followed up with only 1 of the 31 producers who did not report back.

Followup on Loans With Quality Problems in Three ASCS County Offices

County	Number of producers: Asked to take corrective action and report disposition	Who reported disposition	Who did not report disposition and ASCS followed up	Who did not report disposition and ASCS did not follow up
Freeborn, Minn.	22	13	0	9
Marshall, Minn.	21	3	1	17
Poweshiek, Iowa	12	8	0	4
Total	55	24	1	30

An example of the cases in which county offices allowed quality problems to continue uncorrected for an unreasonable period of time follows. On July 12, 1978, the Freeborn County ASCS compliance inspector found one of three bins under one loan had spoilage--"crusting" on the grain surface. On April 10, 1979, he found that the surfaces of two of the bins were black with mold because the bin tops had been off and that the third had started to mold. In October 1979 ASCS paid the producer $916 in advance storage payments even though he had not responded to ASCS' April 11, 1979, letter directing him to correct the problem and report back. On May 23, 1980, the compliance inspector rechecked the bins and still considered the grain to be a problem. ASCS again sent the producer a letter asking him to correct the problem and report back; however, he had not done so 3 months later when we made a followup inquiry.

The other two county offices we visited followed different procedures. Officials in Dodge County, Wisconsin, told us that they verbally informed producers of any quality problems they found; however, they did not document the conversations. Officials in Crawford County, Iowa, told us that they sent letters informing producers of the problem and continued to check problem loans until they were certain the grain was storable. Our review of this county's records confirmed this practice.

Storage practices do not affect amount of storage payments

Grain producers who allow their grain to deteriorate in storage receive the same per-bushel storage amount (as of Nov. 30, 1980, 26.5 cents a bushel for barley, corn, sorghum, and wheat and 20 cents a bushel for oats) as those who maintain grain quality. Also, disincentives exist to clean or screen dockage, 1/ foreign material, and/or broken kernels from grain when it goes into storage because doing so could decrease the producers' eligible bushels, resulting in lower loan amounts and therefore lower storage payments. According to USDA officials, grain traders, and academic professionals we talked with, the presence of dockage, foreign material, and broken kernels may encourage deterioration.

When we discussed the lack of incentives for proper grain management with ASCS officials, they told us that producers are responsible for grain quality and bear the risk of lost revenue from deterioration. They claimed that profit motives should be incentive enough. Because the FOR contains some questionable-quality grain, however, profit appears not to be a sufficient incentive in some cases.

EFFECTS OF QUESTIONABLE GRAIN QUALITY

Permitting grain of questionable quality in the FOR program has financial and other implications. Paying for storage and incurring other program costs, such as waived interest, for questionable-quality grain is not an effective or efficient use of funds. Grain which has diminished in volume or nutritional quality results in a loss to society, brings less revenue to producers, and may jeopardize the adequacy of FOR loan collateral.

Storage payments made for questionable-quality grain

We question the desirability of spending funds to store questionable-quality grain. Assuming that ASCS' profile of farm-stored FOR grain as of September 30, 1979 (see app. II), had been constant throughout the fiscal year, up to 17.9 percent of the total storage earnings, or about $30 million, would have been made for nonstorable or infested grain. We cannot state the actual amount paid for nonstorable or infested grain because all the grain in a bin need not be nonstorable or infested. (See footnote, p. 28.)

1/Lower quality grain and foreign material that is generally deducted from the measured weight in determining the final sales price.

Deterioration reduces grain usefulness

Grain deterioration results in nutritional and economic losses, which have a significant effect on food supplies, producer profits, and collateral security. Insects, rodents, and other prey consume a large volume of stored grain. USDA reported estimated annual storage losses caused by insects during the 10-year period ending 1960 at 324,593,000 bushels of corn, wheat, barley, sorghum, and oats, or about 4.3 percent of the stocks. 1/ In that period's dollar value, the annual loss was nearly $453.8 million.

We could not locate more recent estimates of losses from insect damage, nor did we find published data estimating annual losses from rodents and other prey. However, the results of ASCS' November 1978 quality check of FOR grain stored in Minnesota (see p. 32), which showed animal filth present in 6.2 percent of the bins sampled, indicate that the volume losses from rodents and other prey may also be great. Food processors have no tolerance for animal filth, and therefore the direct nutritional value for humans for all such contaminated grain is lost. Because such contaminated grain may be used as animal feed, however, some nutritional value may reach humans indirectly through the meat and poultry they eat.

Grain deterioration may decrease the processing yield, palatability, or feeding value of grain. For example, an official of a corn refining firm told us that mold, insects, and other agents attack the kernel's germ. The result is a decrease in the amount of oil the germ will yield in processing. An official of a grain processing firm told us that heat-damaged grain has a bitter taste and is therefore avoided. A cattle feeder told us that although grain containing animal filth is fit for animal feed, it is less desirable because of its odor and taste. If cattle will not eat as much grain, it takes longer to fatten them for slaughter; therefore, feed costs are increased.

The same USDA study that estimated the annual dollar loss caused by insects at nearly $453.8 million, estimated additional quantity and quality losses from deterioration at over $92 million. Although this estimate is dated, it demonstrates the significance of such losses. If FOR grain deterioration is great, the value of the grain serving as loan collateral could be less than the loan amount.

ACTIONS TAKEN TO IMPROVE STORAGE PRACTICES

As early as June 1978, an ASCS task force which studied the FOR recommended that ASCS (1) inspect FOR grain more often and (2) undertake an educational effort to make producers aware of the need to watch their commodities and maintain the grain quality.

1/"Agriculture Handbook 291," USDA.

The basis for the recommendation was the task force members' belief that many producers were not familiar with the problems involved in storing grain on the farm for long periods and that some producers mistakenly believed the Government bears the risk of loss from deterioration.

ASCS has taken some steps to educate producers. Early in 1980, it distributed a booklet on insect control in farm-stored grain to participants. The booklet provided excellent information on reasons why infestation occurs, basic requirements for grain bins, and procedures for inspecting stored grain and treating infested grain. It included pictures of insects commonly found in stored grain.

Also, ASCS and the Grain Marketing Research Laboratory of USDA's SEA are conducting research on FOR grain, the results of which might help producers avoid or minimize deterioration. They are accumulating information on the age and quality of grain and producer grain management practices. This project's objectives, as stated in the research proposal, are to

--develop basic information on a national scale to characterize insect and fungal activity in FOR grain stored on farms;

--identify specific biological problem areas within the storage program; and

--suggest corrective actions, where required, to improve and maintain FOR grain quality.

We believe this project is important and will provide useful information.

CONCLUSIONS

The results of ASCS and OIG studies of FOR grain quality show that some FOR grain is nonstorable and/or infested. The questionable-quality grain is caused by either (1) low-quality grain entering the FOR due to inadequate FOR grain quality standards and entrance procedures or (2) grain deteriorating after it is in the FOR because of improper storage management practices and/or the inherent qualities of the grain.

Incurring storage or other program costs, such as waived interest for questionable-quality grain, is not desirable. Questionable-quality grain should not be allowed into the FOR or to remain in the FOR if it has deteriorated in storage.

ASCS should make whatever changes are necessary to eliminate questionable-quality grain from the FOR. To gain a better understanding of the extent to which questionable quality is caused by low-quality grain entering the FOR or grain deteriorating in storage, ASCS should, on a sample basis, obtain official grade determinations on grain entering the FOR. Also, it should continue to monitor the sampled bins and periodically obtain official grade determinations to see what changes take place during the life of the loan. The results of this work should be used to refine eligibility standards. In addition, ASCS should have all grain at least visually inspected immediately before it enters the FOR and improve its followup activities of loans with quality problems to assure that producers take corrective action.

RECOMMENDATIONS TO THE SECRETARY OF AGRICULTURE

We recommend that the Secretary require ASCS to obtain official grade determinations, on a sample basis, as grain enters the FOR and on the same grain each subsequent year (where possible), to develop a profile of FOR grain and determine what characteristics are predictors of storability. This data and other information, such as the Grain Marketing Research Laboratory's analysis of FOR grain quality, can be used to determine whether to establish FOR eligibility criteria and/or modify procedures to further eliminate questionable-quality FOR grain. In addition, we recommend that ASCS improve its guidelines and procedures for identifying grain with quality problems serving as loan collateral and correcting or eliminating quality problems identified.

AGENCY COMMENTS AND OUR EVALUATION

According to USDA (see app. III), the report indicates that the FOR tends to increase farm-stored grain deterioration. It said that it could not substantiate this conclusion because non-FOR farm-stored grain quality was not examined. It also noted that warehouse-stored grain is not immune from quality deterioration during storage. We are not saying that farm-stored FOR grain has a worse deterioration problem than farm-stored non-FOR grain or that warehouse-stored grain quality could not deteriorate during storage. Our message is that the extent of the deterioration problem in farm-stored FOR grain indicates a need for corrective action because producers are receiving payments to store the grain and maintain its quality and because deterioration can lead to nutritional and economic losses, including losses for the producers themselves.

USDA said that there is no conclusive evidence that grain of questionable quality is being permitted to enter the FOR. Because USDA does not obtain an official grade determination on the grain when it enters the FOR, it is difficult to prove whether or not the grain was of low quality when it entered the FOR. Nevertheless, the fact remains that ASCS' procedures do not entirely preclude low-quality grain from entering the FOR.

USDA said that CCC has worked to improve maintenance of FOR grain quality. It said that current procedures require an inspection of grain before FOR loan approval and subsequent annual inspections of each farm-stored FOR loan. According to ASCS procedures, however, the inspection required before FOR loan approval for some feed grain loans can be made at the time the grain is sealed under the price-support loan program, or as much as 9 months prior to FOR loan approval. Further, these inspections are usually only visual inspections and do not entail official sampling or grading.

USDA said that it had reservations about obtaining official grade determinations on a sample basis as grain enters the FOR and on the same grain each subsequent year (when possible). It said that this would require an effort of considerable magnitude with a promise of negligible payoff. It added that its experience has shown that essentially two elements--excess moisture and insects--increase the probability of grain quality deterioration.

We believe the approach we recommend would better identify the quality of the grain entering the FOR. Although we recognize that excess moisture and insects are the primary elements increasing the probability of grain deterioration, we believe other factors, such as the uniformity of quality and the cleanliness of the grain, can also contribute to deterioration. Information on these characteristics and their impact on grain quality would be useful for future FOR decisions.

According to USDA, the procedure for identifying quality problems is adequate, but it recognizes that its procedure for correcting problems could be improved. It said that ASCS is expanding procedures to require that farmers be notified when problems are found and to require that action be taken to eliminate the problem or the loan will be called.

Although USDA believes the procedure for identifying quality problems is adequate, ASCS had acknowledged problems in controls over loan collateral, including procedures for sampling and inspection of farm-stored commodities. The proposed sampling and inspection handbook (see p. 33) should help strengthen these procedures which, when properly followed, should help assure that quality problems are identified. The expansion of procedures for dealing with problems should also help assure that quality problems are corrected.

CHAPTER 4

STORAGE PAYMENT PRACTICES REQUIRE CHANGE

USDA pays producers grain storage payments to encourage FOR program participation. In some cases, however, these payments have been excessive.

--A conservatively estimated $28 million paid to producers for onfarm FOR grain storage in fiscal year 1979 represented an amount above estimated average onfarm storage costs and was, in effect, a producer subsidy.

--Producers earned about $900,000 in barley storage payments after barley reached call status even though the purpose of a call is to force grain from the FOR. A similar situation occurred with oats and sorghum.

--Producers have been allowed to retain unearned storage payments for excessive periods before repayment. Barley producers retained an estimated $2 million in unearned storage payments after barley was called from the FOR, some for as long as 10 months after call status was reached.

The Secretary needs to determine the average cost of FOR grain storage and limit producer storage payments to this amount. In determining the average cost of FOR grain storage, both onfarm and warehouse storage costs should be considered. ASCS has changed its procedures to stop storage earnings when a grain reaches call status but has not amended the program regulations. In addition, new program regulations provide that interest be charged immediately following the maturity date or the originally required settlement date.

STORAGE PAYMENTS SHOULD BE LIMITED TO AVERAGE STORAGE COST

The Food and Agriculture Act of 1977 states that producers are to be paid "such amounts as the Secretary determines appropriate to cover the cost of storing wheat and feed grains held under the program." However, storage rates established by the Secretary have not been based on determinations of FOR grain storage costs. When the FOR was established, the storage rate was set at 20 cents a bushel for corn, wheat, sorghum, and barley. 1/ On February 8, 1979, the annual storage rate on these grains was increased to

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1/ASCS proposed a storage rate of 25 cents a bushel based on average commercial storage rates. The Office of Management and Budget reduced the rate to 20 cents a bushel.

25 cents a bushel to increase program participation. 1/ These rates were established on bases other than the cost of onfarm storage, which represented the majority of FOR storage.

Storage payments to producers in fiscal year 1979 (at 25 cents a bushel) exceeded estimated average onfarm storage costs by from 3.3 cents to 8.6 cents a bushel depending on whether a storage facility is assumed to have a 10-year or 20-year life. For fiscal year 1979, the excess represented $28 million or $72 million to producers storing FOR grain onfarm. In fiscal year 1979, about 76 percent of the FOR grain was stored on the farm, with the balance in commercial storage space. The average annual rate charged for commercial storage space nationwide was about 26.4 cents a bushel for the period July 1, 1978, through June 30, 1979, and about 26.8 cents for the period July 1, 1979, through June 30, 1980.

We found very few studies containing recent cost data on onfarm storage. The latest study we obtained was a master's thesis completed in 1978 by a Kansas State University graduate student. 2/ The study's purpose was to determine the costs of onfarm storage and drying of grain in Kansas. The study results showed that the estimated average annual cost for onfarm storage ranged from 19.2 cents to 10.7 cents a bushel for the smallest and largest facilities, respectively, based on 100-percent utilization and depreciation of the facilities over 20 years and of the equipment over 10 years. The study showed the average annual storage costs for a 10,000-bushel facility to be 15.8 cents a bushel.

Because of the lack of onfarm storage cost data, we developed estimates of such costs based on a random sample of ASCS' fiscal year 1979 storage facility loans, information from other studies, and discussions with county auditors and insurance agents. On the basis of this information, we conservatively estimated that farm storage payments in fiscal year 1979 were at least 3.3 cents a bushel, or a total of at least $28 million, more than the estimated average onfarm storage costs. We assumed a 10-year useful bin life and no salvage value, whereas the useful bin life could be much longer and some facilities may have residual or salvage values. We also assumed 100-percent utilization. Also, we used fiscal year 1979 facility construction costs, although it is unlikely that all FOR participants stored grain in facilities constructed in 1979 and many therefore may have had lower capital costs.

1/Effective Jan. 7, 1980, the annual storage rate on these grains was raised to 26.5 cents a bushel to offset the effects of the Russian grain embargo. This rate remained in effect at Nov. 30, 1980.

2/Randal L. Linville, "The Economics of Farm Grain Storage and Drying in Kansas," Kansas State University, Manhattan, Kansas, 1978.

To calculate farm storage facility costs, we gathered cost and other information on a random sample of the 53,669 storage facility loans which ASCS made during fiscal year 1979. The facilities were of varying sizes with and without drying equipment. From this universe, we selected 1,074 loans for sampling purposes, using a random starting point and selecting each 50th loan from the listing of the 53,669 loans. We drew a subsample of 154 loans and examined the relevant cost information in detail.

For the 154 sample facilities, we identified total capital cost and bushel capacity. The results showed that the sample facilities had an average capacity of about 10,000 bushels and an average per-bushel capital cost of $1.06. The per-bushel capital cost of the individual facilities ranged from $0.41 to $3.62. On the basis of our sample, we are 95 percent confident that the 53,669 loans in our universe had per-bushel capital costs of from $0.41 to $3.62.

Using the average per-bushel capital cost of $1.06, as well as other fixed and variable costs, we calculated that the average onfarm storage cost in fiscal year 1979, as shown in the table on the following page, was 16.4, 18.2, or 21.7 cents a bushel, depending on whether the capital cost is depreciated over 20, 15, or 10 years, respectively.

The difference between the storage payment rate and the estimated average storage cost has changed. For example, the interest rate ASCS charges on storage facility loans fluctuates. As of November 30, 1980, the rate was 12.5 percent. On April 1, 1981, it was raised to 14.5 percent. In addition, the minimum downpayment required on storage facility loans was raised from 15 percent to 25 percent effective April 1, 1981. Other costs have probably also increased due to inflation. These changes further emphasize the need for USDA to determine the average storage costs for purposes of establishing the level of storage payments.

STORAGE EARNINGS ALLOWED TO CONTINUE AFTER GRAIN REACHED CALL STATUS

Until October 1980 ASCS allowed producers to earn storage payments after grain was placed in a call status. This was contradictory because the purpose of call status is to force grain from the FOR. As a result of ASCS' not having procedures to prohibit producers from earning storage payments after a grain had reached call status, storage payments of about $900,000 were earned on barley in 1979 after it was placed in a call status. Storage payments were also earned on oats and sorghum after they reached call status. Effective October 31, 1980, ASCS changed its procedures to stop the earning of storage payments when a grain is placed in a call status.

However, ASCS did not amend its regulations to make them consistent with its newly adopted procedures. ASCS' current

Average Onfarm Storage Cost Per Bushel, Fiscal Year 1979

Cost item	Storage cost per bushel Useful life of storage facility 10 years	15 years	20 years
	----------(cents)----------		
Fixed costs:			
Depreciation (note a)	10.6	7.1	5.3
Interest (note b)	4.9	4.9	4.9
Taxes (note c)	0.7	0.7	0.7
Insurance (note d)	0.6	0.6	0.6
Repairs (note e)	1.1	1.1	1.1
Total fixed costs	17.9	14.4	12.6
Variable costs (note f)	3.8	3.8	3.8
Total cost per bushel	21.7	18.2	16.4

a/Depreciation was calculated on the straight-line method by dividing the average per-bushel capital cost of $1.06 by the respective useful life of 10, 15, or 20 years, assuming no salvage value. Under Internal Revenue Service guidelines, a 10-year life for depreciation of grain bins is acceptable for Federal tax purposes. Grain bin manufacturer representatives told us that grain bins may have a 20-year life or longer.

b/Interest was calculated using ASCS interest rates for fiscal year 1979. ASCS charged 7 percent interest on storage facility loans for the first 6 months of the fiscal year and 10.5 percent for the last 6 months, or an average of 8.75 percent. The producers' minimum downpayment was 15 percent, as required by ASCS regulations. We valued the producers' downpayment money at 12 percent interest per year. The 8.75-percent rate at 85 percent of the facility cost and the 12-percent rate at 15 percent of the facility cost resulted in an overall effective interest rate of 9.24 percent. This rate was applied to the average investment, the average investment being considered one-half the producer's cost.

c/Property taxes were calculated at 0.7 percent of original capital investment, based on data from earlier studies and contacts with county auditors.

d/Insurance was calculated at 0.6 percent of original capital investment, based on data in other studies and discussions with insurance agents.

e/Repairs were calculated at 1 percent of original capital investment, based on the Kansas State University study.

f/Variable costs include such items as grain insurance, insect control, aeration, handling, and weight loss. The amount was based on the Kansas State University study—the highest estimate of variable cost in any of the studies reviewed.

regulations provide only that storage earnings stop at the end of the month following the month in which release status is reached.

Barley

Barley (reserve I) reached release status on June 5, 1979, at which time ASCS informed producers that storage payments could be earned at least through July 31, 1979. On June 26, 1979, barley reached call status. Instead of stopping storage earnings at that time, ASCS announced that storage earnings would stop the earlier of (1) the date of repayment or (2) August 5. Little barley was redeemed or forfeited before August 5. During the period June 26 to August 5, 1979, or about 40 days, producers earned an estimated $900,000 in storage payments on barley.

Barley represented only about 3 percent of the FOR grain in early June 1979, thus the storage earnings amount involved was not large. However, had similar circumstances occurred for wheat, for example, the storage earnings involved would have been 10 times greater.

USDA's Director of Economics, Policy Analysis, and Budget told us that USDA had not anticipated that grains would reach call status so quickly after they reached release status. He said that under anticipated circumstances, storage earnings would have stopped under the rules of release before call status was reached.

Oats and sorghum

Similar situations occurred for oats and sorghum. However, we did not calculate the amounts of storage earned after each grain reached call. The amounts for oats would likely be less than barley and the amounts for sorghum would likely be more than barley, considering the volume of oats and sorghum in the FOR.

On September 10, 1980, oats (reserve III) entered release status, and storage earnings were to continue through October 31, 1980. On September 17, 1980, this grain entered call status, yet storage earnings continued through October 31, 1980, or 44 days after the grain entered call status.

Sorghum (reserves I and II) entered release status on July 2, 1980, and storage earnings were to continue through August 31, 1980. On July 17, 1980, sorghum (reserve I) entered call status, but storage earnings continued through August 31, 1980, or 45 days after call status was reached. On July 25, 1980, sorghum (reserve II) reached call status; however, storage earnings continued through August 31, 1980, or 37 days after call status was reached.

In commenting on a draft of this report (see app. III), USDA said that it had recognized this problem and changed its procedures. It said that announcements of storage earning dates now provide that these earnings will continue through a specified date, unless the commodity is called before that date.

USDA SHOULD COLLECT UNEARNED STORAGE PAYMENTS AT CALL WHEN THE PERIOD OF REDEMPTION OR FORFEITURE IS EXTENDED

ASCS has allowed producers to retain unearned storage payments for unreasonable lengths of time when the redemption period was extended. ASCS regulations provide that unearned storage will either be subtracted from any future storage payment or will be collected when the loan is redeemed or forfeited to CCC. In the case of barley, ASCS allowed producers to retain an estimated $2 million in unearned storage payments, some for as long as 10 months after barley was called from the FOR. This situation occurred for two reasons: (1) ASCS for various reasons extended the 30-day period producers had to redeem or forfeit their barley for up to 11 months in some States 1/ and (2) ASCS procedures do not provide for collecting unearned storage payments under these circumstances.

Unearned storage payments occur when a grain has been in release status for a period during the year and storage earnings have stopped or when a grain enters call status before the storage earnings period has expired. ASCS does not review loans or consider unearned storage payments unless the producer (1) redeems or forfeits the grain or (2) is entitled to an advance storage payment for the upcoming year. Any unearned storage payments are offset against the settlement proceeds or the next year's advance storage payment.

Barley reached release status on June 5, 1979. USDA stated that storage earnings would continue through July 31, 1979, at which time it would determine whether the release status would continue. On June 26, 1979, all barley (about 40 million bushels) was called from the FOR. On August 5, 1979, barley loans stopped earning storage payments.

Although some producers redeemed their barley loans after call status was reached, about 23.1 million bushels remained in the FOR in mid-May 1980, when USDA stopped reporting the amount of called barley in the FOR. We estimate that producers holding this grain retained about $2 million in unearned storage payments. Some producers retained these unearned payments for as long as 10 months beyond the date barley entered call status because ASCS did not have a procedure for collecting unearned storage payments at the end of the initially announced redemption or forfeiture period after a grain reaches call status.

1/The time period producers are allowed to redeem or forfeit their grain after call status is reached was increased to 90 days in Sept. 1980.

Consider the hypothetical case of a producer who had a barley loan with an effective date of October 1, 1978. On or about October 1 each year, he would receive an advance annual storage payment for the period October 1 through September 30. The producer earned storage payments through August 5, 1979, when earnings on barley were stopped. Therefore, on September 30, 1979, the last day of his annual storage period, he would have received storage payments for nearly 2 months (August and September) which he had not earned. Assume the producer held the barley during the extended call status period until May 1980. When he redeemed his loan in May 1980, that would be the first time ASCS had reviewed the loan and considered the unearned storage payments for the August-September 1979 period because barley had not been in a storage earning status. At that time he would have to repay the 2 months' unearned storage payments.

In this case the producer would have been allowed to retain these unearned storage payments for about 10 months (August 1979 through May 1980) beyond the date barley entered call status and storage earnings stopped. Delays in collecting these unearned payments deprive the Federal Government of the use of those funds and increase Federal interest costs if the Treasury has to borrow funds to meet governmental needs.

CONCLUSIONS

The estimated annual average cost of storing grain on the farm in a facility purchased in fiscal year 1979 was about 21.7 cents a bushel, assuming a 10-year useful bin life, while USDA paid for storage at the rate of 25 cents a bushel. Thus, producers were paid about 3.3 cents a bushel more than the estimated average cost of storing grain onfarm in 1979. This difference could be even greater because the useful bin life could be much longer. Storage payments should be limited to average storage costs, which should include both onfarm and warehouse storage costs. ASCS has changed its procedures to provide that storage payments stop when a grain reaches call status. It should amend its regulations to be consistent with these procedures. Also, ASCS amended its regulations to provide that interest be charged following the maturity date of the loan or the originally required settlement date.

RECOMMENDATIONS TO THE SECRETARY OF AGRICULTURE

We recommend that the Secretary determine the average cost of FOR grain storage and limit producer storage payments to this amount. In determining the average cost of FOR grain storage, both onfarm and warehouse storage costs should be considered. We also recommend that the Secretary amend program regulations to make them consistent with ASCS procedures which provide that storage earnings stop in all cases when a grain reaches call status.

AGENCY COMMENTS AND OUR EVALUATION

USDA agreed that the average storage cost should reflect both onfarm and commercial storage costs but said that it was difficult to ascertain the average cost of storing FOR grain. (See app. III). It said we used storage cost estimates from the Kansas State University graduate student's thesis, which was based on 1977 data, and that USDA analysts believed the costs were underestimated. It said that storage costs have risen significantly since that time due primarily to inflation.

While we used the Kansas State University graduate student's thesis, among other sources, to determine the lesser cost items, the majority of the cost (15.5 cents) was based on actual fiscal year 1979 data. We recognize that farm storage costs have risen. (See p. 42.) We believe such increases emphasize the need for USDA to determine the average cost of onfarm and warehouse storage and establish a rate based on this data.

USDA said that it realizes that some producers may profit from the applicable storage rates while others will realize losses. It said that storage rates are not intended to induce producers to participate in the FOR but that these rates should not discourage utilization of the program. Although storage rates may not always be set to encourage program participation, the President's announcement of the increase in rates from 20 to 25 cents in February 1978 indicated that the increase was for the purpose of increasing program participation.

USDA said that it had recognized that storage earnings should be stopped in all cases when grain reaches call status and that it had changed its procedures. It said that announcements of storage earning dates now provide that these earnings will continue through a specified date, unless the commodity is called before that date. However, ASCS should also amend its regulations to make them consistent with its newly adopted procedures.

On the matter of collecting unearned storage payments at the end of the initially announced redemption or forfeiture period after a grain reaches call, USDA said that it had amended its regulations to provide that interest be charged immediately following the maturity date or the originally required settlement date. It said that this action should encourage producers to settle their matured and called loans and repay unearned storage payments timely but that, if this action did not prove to be effective, other changes would be considered to effect timely settlement.

We believe USDA's actions will be beneficial. However, since this has not yet been tested, we have no means of assessing whether or not it will provide for an effective method of collecting unearned storage payments.

FARMER-OWNED RESERVE: CHRONOLOGY OF ACTIONS

1977:

Apr. 4 Increased price-support loan rates.

	Old loan rate	New loan rate
	(per bushel)	
Wheat	$2.25	$2.25
Corn	1.50	1.75
Oats	.72	1.00
Barley	1.22	1.50
Sorghum	1.43	1.70

Lowered commodity loan interest rate from 7-1/2 percent to 6 percent.

Established an FOR program for 1976 crop wheat and rice.

June Initial entries of FOR wheat.

Aug. 29 ASCS Administrator announced plans to form 30 to 35 million metric tons (MMT) farmer-owned food grain (wheat and rice) and feed grain (corn, sorghum, barley, and oats) reserve. Was to consist of 8.2 MMT wheat reserve, 17 to 19 MMT feed grain reserve, 6 MMT international food reserve, and 0.6 MMT rice reserve.

Sept. 29 Effective date of Food and Agriculture Act of 1977, which provides statutory basis for the FOR. The act provided for a wheat FOR of not less than 300 million bushels or more than 700 million bushels.

Oct. 19 Minimums/maximums for feed grains FOR proposed.

	Minimum	Maximum
	(million metric tons)	
Corn	12.75	14.25
Sorghum	1.87	2.09
Barley	1.02	1.14
Oats	1.36	1.52
Total	17.00	19.00

1977:

Dec. 6	Announced expansion of FOR to include 1976 and 1977 crop corn, oats, sorghum, and barley, and 1977 crop wheat.
	Announced storage rates to participating producers of 20 cents a bushel for wheat, corn, sorghum, and barley and 15 cents a bushel for oats.

1978:

Feb. 6	Announced entry eligibility before price-support loan maturity for 1977 crop wheat, barley, and oats.
Feb. 9	Increased annual storage rate from 20 cents to 25 cents a bushel for wheat, corn, sorghum, and barley and from 15 cents to 19 cents a bushel for oats.
Feb. 28	Last day to transfer 1976 crop wheat, barley, and oats under price-support loan into the FOR.
Mar. 29	Announced waiver of interest charges after first year for all FOR grains.
	Announced entry eligiblity before price-support loan maturity for 1977 crop corn and sorghum.
Apr. 30	Deadline for transferring 1976 crop corn and sorghum into the FOR.
June 9	Announced commodity loan interest rate of 7 percent for commodity loans on 1978 crops.
July 5	Release status reached on barley (I). 1/
July 29	Reopened corn and sorghum loan program for 2 months but only for producers wanting entry into the FOR prior to price-support loan maturity.
Aug. 2	Withdrew release authorization for barley (I).
Oct. 5	Announced entry eligibility for 1978 crop corn.
Nov. 27	Announced no more 1978 crop corn accepted.

1/Roman numerals refer to reserve designations discussed on pp. 3 and 4 of ch. 1.

1979:

Jan. 1	Initiated quality check of farm-stored FOR grain.
Mar. 12	Release status reached on oats (I).
May 2	Withdrew release authorization for oats (I).
May 11	Release status reached on oats (I).
May 16	Release status reached on wheat (I).
May 24	Announced commodity loan interest rate of 9 percent for 1979 crop commodity loans.
June 5	Release status reached on barley (I).
June 12	FOR quality check followup instructions issued.
June 19	Release status reached on corn (I).
June 22	Release status reached on sorghum (I).
June 26	Call status reached on oats (I).
	Call status reached on barley (I).
Aug. 1	Withdrew release authorization for corn (I).
	Withdrew release authorization for sorghum (I).
Aug. 1	Oats reentered the FOR.
Aug. 31	Initiated quality check of farm-stored FOR grains to be done in September.
Sept. 6	Release status reached on sorghum (I).
Sept. 20	Release status reached on oats (I).
Oct. 3	Release status reached on corn (I).
Oct. 22	Announced entry eligibility before price-support loan maturity for 1978 and 1979 crop corn, oats, sorghum, and wheat under price-support loan or eligible for loan.
Oct. 31	Withdrew release authorization for sorghum (I).
Nov. 30	Withdrew release authorization for corn (I).

1980:

Jan. 4 President announced embargo on grain shipments to the Soviet Union.

Jan. 8 Announced following changes to be effective Jan. 7, 1980:

--Increased release level for wheat from 140 percent to 150 percent; feed grains remain at 125 percent.

--Increased call level for wheat to 185 percent; feed grains to 145 percent.

--Waived interest on first 512 million bushels of corn entering the FOR for the first time.

--Increased storage rates to 26.5 cents a bushel for wheat, corn, sorghum, and barley and 20 cents a bushel for oats.

--Increased 1979 loan rates and release and call levels

	Old loan rate	New loan rate	New release level	New call level
	(per bushel)			
Wheat	$2.35	$2.50	$3.75	$4.63
Corn	2.00	2.10	2.63	3.05
Oats	1.03	1.08	1.35	1.57
Barley	1.63	1.71	2.14	2.48
Sorghum	1.90	2.00	2.50	2.90

Jan. 18 Release status reached on wheat (II).

Jan. 23 Waived interest on corn entering the FOR between Oct. 22, 1979, and Jan. 7, 1980, and corn producers were required to sign a new agreement (reserve II) to qualify. Producers remained liable for interest through Jan. 6, 1980.

Feb. 1 Withdrew release authorization for oats (I).

Feb. 7 Release status reached on oats (I and II).

Mar. 3 Withdrew release authorization for wheat (II).

1980:

Mar. 18	Announced increases in target prices: wheat--$3.63, corn--$2.35, sorghum--$2.50, and barley--$2.55. There was no target price for oats.
Mar. 25	FOR quality check followup instructions issued.
Apr. 1	Withdrew release authorization for oats (I and II).
Apr. 15	Release status reached on oats (I and II).
	Announced increase in 1979 crop year commodity loan interest rate from 9 percent to 13 percent for all loans made on or after Apr. 16, 1980. The 13-percent rate also applies to 1980 crop year commodity loans.
Apr. 16	Announced eligibility of nonparticipants to place 1979 crop corn in the FOR through May 15; interest on these loans not waived.
May 2	Withdrew release authorization for wheat (I).
May 8	Release status reached on wheat (I).
May 13	Announced extension of nonparticipant eligibility to place 1979 crop corn in the FOR from May 15 to June 13.
May 22	Announced new barley FOR (II) for 1978 and 1979 crop barley.
May 23	Call status reached on oats (I).
June 5	Announced quality check to be done in June 1980 for oats and wheat only.
June 12	Announced reduction in 1980 crop commodity loan interest rate from 13 percent to 11.5 percent.
July 2	Release status reached on sorghum (I and II).
July 8	Release status reached on barley (II).
	Release status reached on wheat (II).
July 11	Release status reached on corn (I and II).
July 15	Call status reached on oats (II).

1980:

July 17 Call status reached on sorghum (I).

July 25 Call status reached on sorghum (II).

July 28 Announced 1980 crop loan rates.

Reduced release level for wheat from 150 percent to 140 percent for reserve III agreements.

Reduced call level for wheat from 185 percent to 175 percent for reserve III agreements.

Changed loan rates and release and call levels.

	New loan rate	Release levels			Call levels		
		I	II	III	I	II	III
	(per bushel)						
Wheat	$3.00	$4.20	$4.50	$4.20	$5.25	$5.55	$5.25
Corn	2.25	2.81	2.81	2.81	3.15	3.26	3.26
Oats	1.16	1.45	1.45	1.45	-	-	1.68
Barley	1.83	-	2.29	2.29	-	2.65	2.65
Sorghum	2.14	2.68	2.68	2.68	-	-	3.10

Note: Blanks indicate grain was in call status.

Aug. 18 Announced quality check, to be done in Sept. 1980, for FOR corn.

Aug. 29 Release status reached on corn (III).

Release status reached on sorghum (III).

Sept. 5 Withdrew release authorization for wheat (I and II).

Withdrew release authorization for barley (II).

Sept. 8 Time allowed for producers to settle loans after call changed from 30 days to 90 days.

Allowed producers with reserve I and II contracts to convert to reserve III; conversion must be exercised before call status is reached.

Sept. 10 Release status reached on oats (III).

1980:

Sept. 17	Call status reached on oats (III).
Oct. 22	Release status reached on barley (II and III).
Oct. 22	Release status reached on wheat (I and III).
Oct. 23	Changed method for determining FOR grain call level. Grain called when the 5-day moving average price is at or above the commodity's call level for 5 consecutive market days.
Oct. 31	Call status reached on corn (I).
Nov. 6	Call status reached on sorghum (III).
Nov. 12	Issued FOR oats and wheat quality check followup instructions.
Dec. 3	President signed the Agricultural Act of 1980 (Public Law 96-494), which increased loan rates for 1980 crop grains placed in the FOR.
	Legislation also waived all interest on loans for 1980 and 1981 crop grains placed in the FOR.
Dec. 8	Changed method for determining FOR grain call level to allow Secretary discretion not to call grains if the daily adjusted average price for any of the previous 5 days was below the call level.
Dec. 30	Call status reached on corn (II and III).

1981:

Jan. 6	Withdrew release authorization for wheat (I and III).
Feb. 5	Announced a 30-day extension on FOR corn (I, II, and III) and sorghum (III) settlements because of transportation problems. During the 30-day period, producers will pay 15.25 percent on their loans.

RESULTS OF ASCS 1978 and 1979 RESERVE GRAIN QUALITY CHECKS

Reserve Quality Based on 1978 and 1979 Quality Checks (note a)

Type of grain	Total bushels		Storable (notes b, c) U.S. No. 1, 2, or 3		Storable (notes b, c) U.S. No. 4, 5, or Sample		Nonstorable Any U.S. grade	
	1978	1979	1978	1979	1978	1979	1978	1979
	(000 omitted)		(percent)					
Barley	30,701	32,844	85.2	82.3	7.8	7.8	7.0	9.9
Corn	303,199	465,799	84.2	80.0	9.2	3.9	6.6	16.1
Oats	35,704	30,897	71.8	70.8	25.4	25.0	2.8	4.2
Sorghum (note d)	18	20	77.8	72.9	11.1	7.9	11.1	19.3
Wheat	253,990	205,573	87.0	88.3	8.9	4.5	4.1	7.2
Total	623,612	735,133	84.7	82.0	9.9	5.2	5.4	12.8

a/Because of differences in the universe of loans sampled, the 1978 and 1979 quality checks should not be compared statistically.

b/U.S. grades are official standards based on various quality factors for each grain. The standards facilitate grain trading by enabling buyers and sellers to transact sales based on the grain's grade rather than on personal observation. Some of the quality factors are test weight per bushel, percent of damaged kernels, moisture content, and percent foreign material. The numerical grade reflects the lowest grading factor. The highest numerical grade is No. 1, while the lowest is either Nos. 4 or 5 (for grains in the FOR), depending on the type of grain. The designation "Sample grade" means that one or more quality factors is lower than the minimum requirement for any grade.

c/The groupings of U.S. Nos. 1, 2, or 3 and U.S. Nos. 4, 5, or Sample grade were done by ASCS.

d/Percentages for 1979 do not total due to rounding.

The table below shows for the 1979 quality check the percentages of nonstorable grain and infested grain by commodity and crop year.

Commodity	Total bushels stored on farms (note a)	Percent non-storable bushels	Percent non-storable and infested bushels
	(000 omitted)		
1976 Barley	1,977	7.6	8.4
1977 Barley	30,867	10.0	13.7
1976 Corn	7,528	31.1	35.0
1977 Corn	324,477	18.0	23.3
1978 Corn	133,794	10.5	14.9
1976 Oats	344	0.3	14.1
1977 Oats	30,553	4.3	14.4
1976 Sorghum	1	-	-
1977 Sorghum	20	20.0	50.3
1976 Wheat	102,712	6.1	10.2
1977 Wheat	102,861	8.2	13.4
Total	b/735,134	12.8	17.9

a/The data represents estimates based on a statistically random sample projected to U.S. total in the FOR as of Sept. 30, 1979.

b/This total differs from the one on the previous page due to rounding.

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

MAR 2 6 1981

TO: Henry Eschwege, Director
Community and Economic Development
Division

SUBJECT: Comments on Draft Report Entitled "The Farmer-Owned
Grain Reserve -- It Has Partially Met Its Objectives
But Modifications are Needed"

This report focused on three major issues: The ability of the farmer-owned reserve (FOR) to meet its objectives, quality of grain stored in the FOR and storage payment practices. The report is based on the findings of two independent studies commissioned by GAO, analyses undertaken by this Department and the investigation by GAO of certain issues related to the FOR. Our comments include those of a summary nature and those specifically focused on the recommendations. Separate detailed reviews of the GAO report are attached.

Summary Comments

The Department believes that the FOR program has been relatively successful, realizing the problems associated with its implementation and other problems such as the USSR grain embargo. This conclusion is supported by the GAO Report. However, GAO points out that their conclusions can only be considered tentative due to the short time that the FOR has been in operation. The FOR was evaluated during its initial three year (crop year) period 1977-79, a time of stock accumulation and adjustment in program administration. A longer period will no doubt provide a stronger basis for more definitive analyses.

As implemented, the FOR has been viewed as a tool which would come into play when unplanned or unexpected shifts in supply or demand caused a material inbalance between the two. When grain supplies substantially exceed demand at prices close to or below target price levels, grain enters the FOR. When the opposite occurs, grain is removed from the reserve. Thus, producers and consumers are protected from extreme fluctuations in prices.

To the extent that the FOR is effective it should temporize price variability by reducing the magnitude of the peaks and valleys. Hence, the range through which prices vary could be narrowed, while even shifting upward. The two studies commissioned by GAO reached conflicting conclusions on this question. One

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study reported an increase in price variability in the short-run, while the other reported a decrease. Results from other analyses (simulation studies) suggest that a FOR should reduce variability.

Both commissioned studies suggested that inventories were increased little above levels that would have been held in the absence of the FOR. A 2 to 4 bushel increase of grain in the FOR was required to increase total inventories by one bushel. These studies miss an important point. If the FOR had not been in existence these stocks, if held, would have been held primarily by non-producers and prices would have been sharply lower, thereby contributing to increased year-to-year price and production instability. Also, if prices were driven below redemption costs, the Commodity Credit Corporation (CCC) could have become a major storer of grain, a point the studies have not recognized.

One of the commissioned studies stated that the livestock sector was adversely affected by the FOR. Department analysts believe that, given the stage in the cattle cycle and financial market conditions, the problem was caused primarily by lower livestock product prices and high interest rates rather than higher corn prices associated with the FOR.

Both studies tended to concentrate on how the FOR worked in 1977-79, a time of stock accumulation and initial program implementation. This analysis was complicated by the impact of the grain embargo to the USSR. A study based on a longer period and of a different methodological approach (i.e., simulation analysis) would provide more insight into the longer-run effects.

The FOR enhanced producers' income in surplus production years and provided confidence to domestic and foreign markets during short crop years. These are important benefits which are not adequately treated in the report.

<u>Comments on Specific Recommendations made by GAO</u>

A. The Farmer-Owned Reserve Has Not Fully Met Its Objectives and Needs Modification.

GAO Recommendations:

(1) <u>The program should be modified to provide for methodical adjustments in program operations, while still allowing for some necessary flexibility</u>.

The Department agrees with this recommendation, and in fact numerous changes have been made to simplify the program, to reduce the need to make changes, and to make it better serve producers and consumers. The Department intends to continue these efforts.

(2) <u>Remove quantity limits</u>.

(3) <u>Emphasize long-term stabilization</u>.

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(4) Allow non-producers to participate.

The Department has reservations regarding recommendations (2) and (4); however these recommendations will be examined as the farmer-owned reserve is reviewed in relation to other policy instruments.

Currently, all aspects of the farmer-owned reserve are being reviewed. The Department will work with the Congress to provide a workable reserve program that will address the needs of all segments of the farm community and the nation as a whole.

B. Quality of Farm-Stored Reserve Grain is Questionable.

It indicates that the farmer-owned reserve tends to increase the deterioration of farm-stored grain. We cannot substantiate this conclusion, since quality of non-reserve farm stored grain was not examined. It should be noted further that warehouse-stored grain is not immune from quality deterioration during storage.

The report also indicates that since low quality grain has been found by reserve spot checks, grain of questionable quality is being permitted to enter the reserve. There is no conclusive evidence which suggests this conclusion. The storage of grain requires constant vigilance during the storage period, regardless of whether or not it is stored on the farm or in a warehouse. When farm-stored grain is placed under CCC loan, the producer is responsible for maintaining the quality of the grain. If the grain is ultimately delivered to CCC, the settlement is based on the quality of grain delivered. Even so, CCC has worked to improve maintenance of grain quality stored in the FOR. Current procedures require an inspection before a reserve loan is approved and there are subsequent annual inspections of each farm-stored reserve loan.

Two specific recommendations were made in regard to maintaining quality.

(1) That ASCS be required to obtain official grade determinations on a sample basis as grain enters the reserve and on the same grain each subsequent year (when possible) to develop a profile of reserve grain to determine what characteristics are predictors of storability.

The Department has some reservations to this approach. Our experience indicates that there are essentially two elements which increase the probability of grain quality deterioration. These are excess moisture and insects. To develop a profile of FOR-stored grain would require an effort of considerable magnitude with a promise of negligible pay off.

(2) That ASCS improve its guidelines and procedures for identifying loans secured by grain with quality problems and correcting or eliminating quality problems identified.

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The Department believes the procedure for identifying quality problems is adequate. However, it recognizes the procedure for correcting problems could be improved. ASCS is expanding procedures to require that farmers be notified when problems are found and to require that action be taken to eliminate the problem, or the loan will be called.

C. Storage Payments Exceed Storage Costs.

GAO made one recommendation regarding storage payments.

(1) The Department should determine the average cost of reserve grain storage and limit producer storage payments to this amount.

The Department agrees with GAO that the average storage cost should reflect both on-farm and commercial warehouse storage costs. It is difficult to ascertain the average cost of storing reserve grain. The costs may vary greatly by area. There are few current studies addressing the costs. The GAO report uses estimates of farm-stored costs included in a master's thesis completed by a Kansas State University graduate student in 1978 but based on 1977 data.

Department analysts believe that farm storage costs were underestimated. Since that time the costs of storing grain have risen significantly due primarily to inflation. Energy is required for most of the operations; its cost has risen most sharply. When farmers store grain on the farm for an extended period, the costs can become distorted if the basis has been calculated on annual storage elements. The farmer will probably be required to fumigate the grain more often. Grain stored for shorter periods quite often requires no fumigation.

We realize that some farmers may profit from the applicable storage rates while others will realize losses. Although the storage rates are not intended to induce farmers to participate in the reserve, these rates should not discourage utilization of the program.

D. Storage Earnings Allowed to Continue after Call Status is Reached.

Procedures should be established to stop storage earnings in all cases when grain reaches call status.

The Department has recognized this problem and procedures have been changed; earnings stop when a reserve is called.

Beginning with the call of corn Reserve I on October 31, 1980, storage earnings are stopped on or before the call date. Notices announcing storage earnings dates now provide that these earnings will continue through a specified date, unless the commodity is called before that date.

E. Unearned Storage Payments Not Collected on a Timely Basis.

Unearned storage payments should be collected at the end of the initially announced redemption or forfeiture period after a grain reaches call status. [See GAO note 1 below]

The Department has recently amended the regulations to provide that interest be charged immediately following the maturity date or the originally required settlement date. Interest will be charged at the higher of the rate recorded on the loan document or the rate CCC is required to pay the U. S. Treasury in January of the year in which maturity is reached.

This action should encourage producers to settle their matured and called loans and repay unearned storage payments in a timely manner. If this action does not prove to be effective, other changes will be considered as necessary to effect timely settlement.

The Department recognizes that any changes or modifications will affect the welfare of grain producers, livestock producers, others in the system and the Federal budget. Thus, the need exists for a careful on-going examination of the interrelated factors and benefits essential to farmer participation in a FOR that is cost-effective and facilitates assuring adequate supplies for meeting domestic, export and carryover requirements. The Department will continuously monitor and assess the program from this perspective.

Specific comments from Departmental agencies are enclosed for your consideration.

SEELEY G. LODWICK
Under Secretary for
International Affairs and
Commodity Programs - (designate)

Enclosures [See GAO note 2 below]

GAO note 1: This proposal in our draft report has been deleted from the final report.

GAO note 2: The material in the enclosures, which are not reproduced herein, was considered in finalizing the report.

(022500)

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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.

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JUNE 26, 1981

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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 benefit. There is redistribution from consumers to producers and, to the extent that deficiency payments are reduced, from consumers 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 marketplace.

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 disruptions 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 evidence 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 complexities of grain markets, and the lack of some important data, estimates of the program's effects are uncertain. Nevertheless, the overall evidence indicates problems sufficient 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 accumulation 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 FOR 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 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 Total	Wheat Private (note b)	Wheat CCC (note c)	Wheat FOR	Corn Total	Corn Private (note b)	Corn CCC (note c)	Corn 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	180	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: Privately owned	Wheat: Government owned	Wheat: Stocks as a proportion of supply (note b)	Corn: Privately owned	Corn: 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 <u>change</u> 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 <u>stationarity</u>. In general, one would want to allow for <u>nonstationarity</u>--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 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

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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 adjustments would require a research project even larger than the long-run equilibrium models discussed earlier. The closest 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 (<u>op. cit.</u>) 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.

SECTION 3

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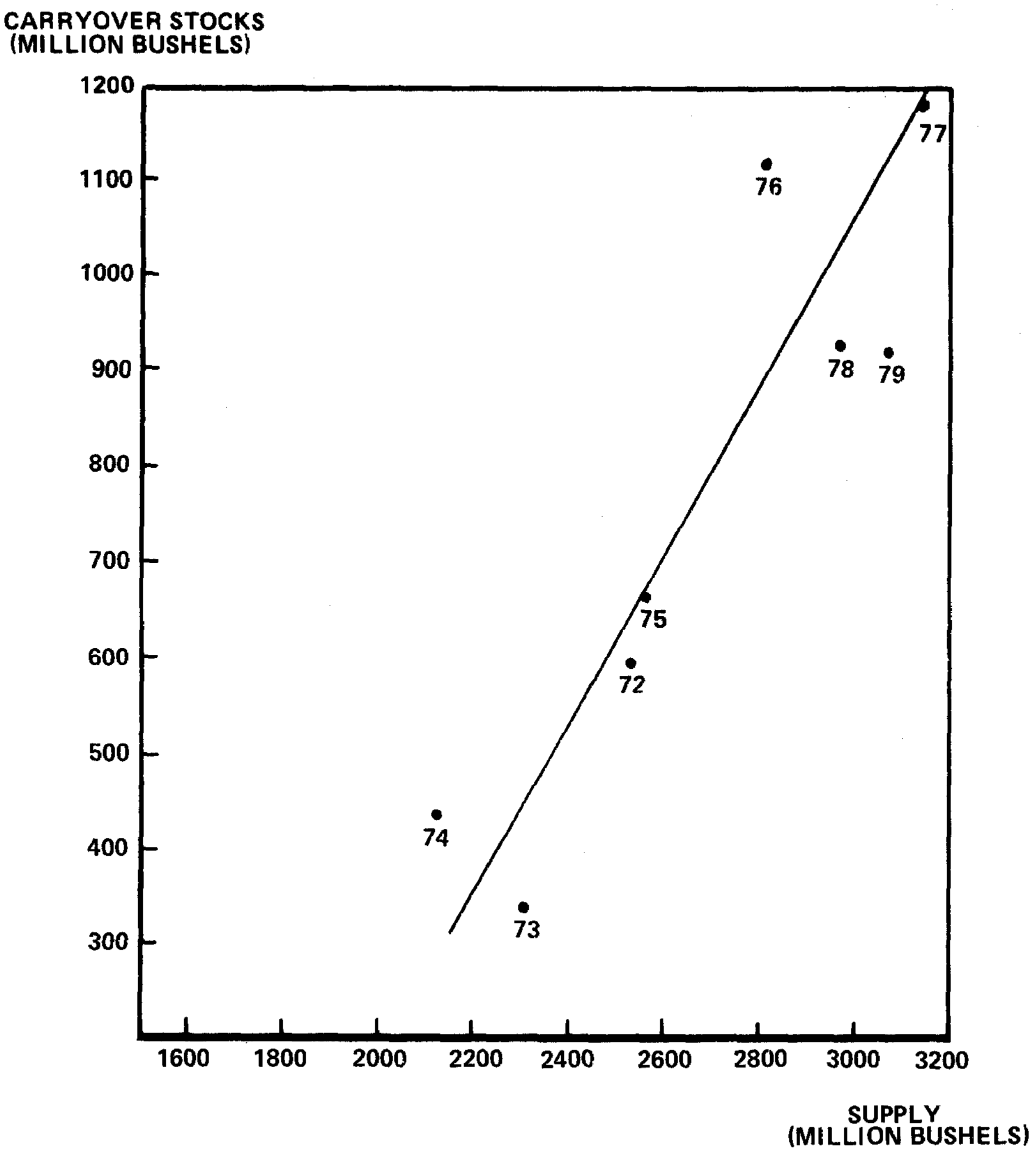
1/Storage rules will not in general be linear, but no apparent departures from linearity are in this particular data.

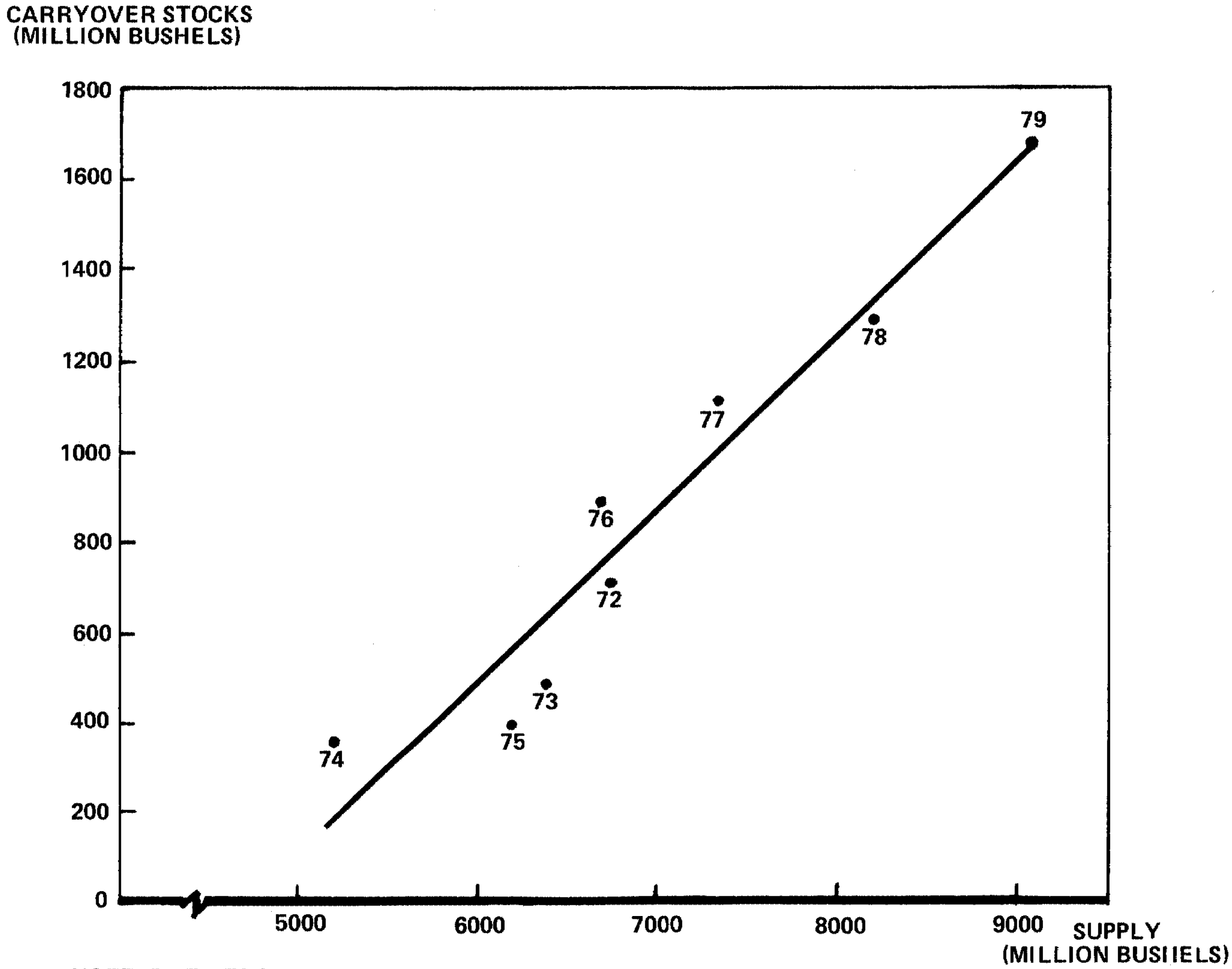
FIGURE 1

WHEAT STOCKS AND SUPPLY



NOTE: DATA FROM TABLE 2.

FIGURE 1A
CORN STOCKS AND SUPPLY



NOTE: DATA FROM TABLE 2.

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:

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

(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:

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

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:

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

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

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:

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

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 associated with FOR in the regressions and in figure 1 could be a consequence of the export situation and not of the FOR program. 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 relevant 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)	Variables (note a) 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 regressions 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 effectiveness 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 consideration in that measures were put in place to encourage stockholding 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 to 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

SECTION 1

INTRODUCTION

The purpose of this study is to review and evaluate theoretical concepts relating to buffer stock policy in the agricultural economy and to consider implications for empirical evaluation of the reserve policy under the Food and Agriculture Act of 1977 on the various major agricultural sectors in view of these theoretical results. The latter analysis focuses specifically on producers of wheat, feed grains, beef, hogs, and poultry and on consumers.

The effects of the policy are evaluated using the concept of economic surplus. Economic surplus is defined as the real income or net benefit derived by producers or consumers from participating in a particular market. With simple concepts of supply and demand, one can readily estimate the effects of a policy on prices and market quantities, but some additional measure of economic welfare is needed to determine whether such changes are beneficial or not (and by how much) for each group of producers and consumers. For example, the amount of a price increase multiplied by the quantity a consumer was consuming before the price increase generally overestimates the change in his real income; he may be better off by consuming less and diverting some expenditure to goods which were almost preferred before the change. The concept of economic surplus accounts for these possibilities in the case of both producers and consumers. In this sense, this study may be regarded as a cost-benefit analysis of the reserve policy enacted by the Food and Agriculture Act of 1977 (although administrative costs are not considered).

Changes in economic surpluses measure changes in real income for market participants. The theory of economic welfare has shown that economic surplus or real income changes can be calculated using consumer demand and producer supply curves. 1/ One can view a demand curve as specifying the maximum amount that a consumer is willing to pay for each additional unit of a product. For example, in figure 1, p2 is the maximum price that a consumer would pay for an additional unit of consumption if he were already consuming q2. Thus, if a consumer actually pays price p1 for every unit of the product, then he has an excess

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1/M. Currie, J. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," Economic Journal, Vol. 81 (1971), pp. 741-799.

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 stockholding. (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 welfare 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.

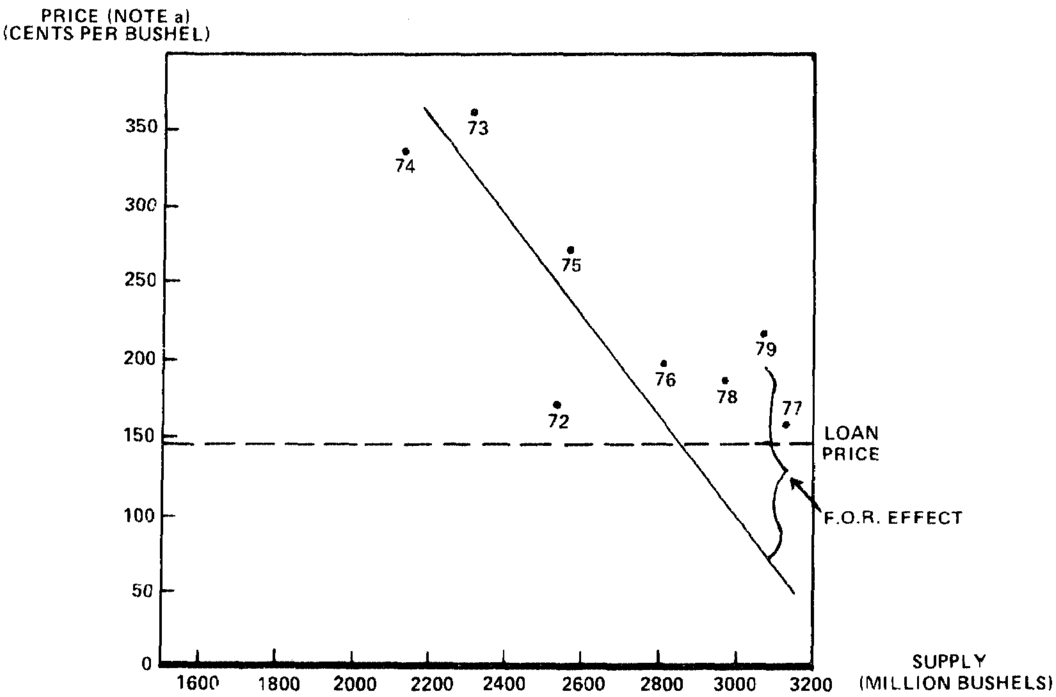
If adding 400 million bushels to the FOR results in an addition of 100 million bushels to total stocks, then 100 million bushels less must have gone into consumption and export channels. Because of this change, market prices should have been increased by FOR accumulation. Once the stocks are accumulated, 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.

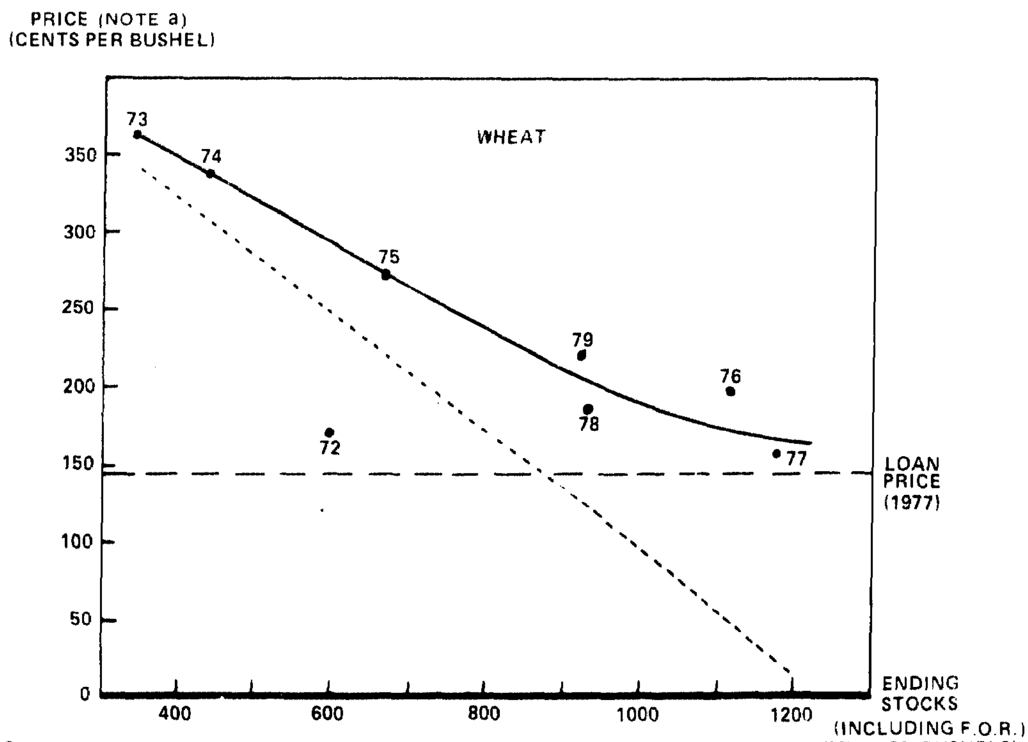
To analyze the actual effects of the FOR program on grain prices, we need a model essentially like the ones used to explain ending stocks. Indeed, ending stocks and prices are both endogenous variables in the same simultaneous system used in the regressions of table 3.

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

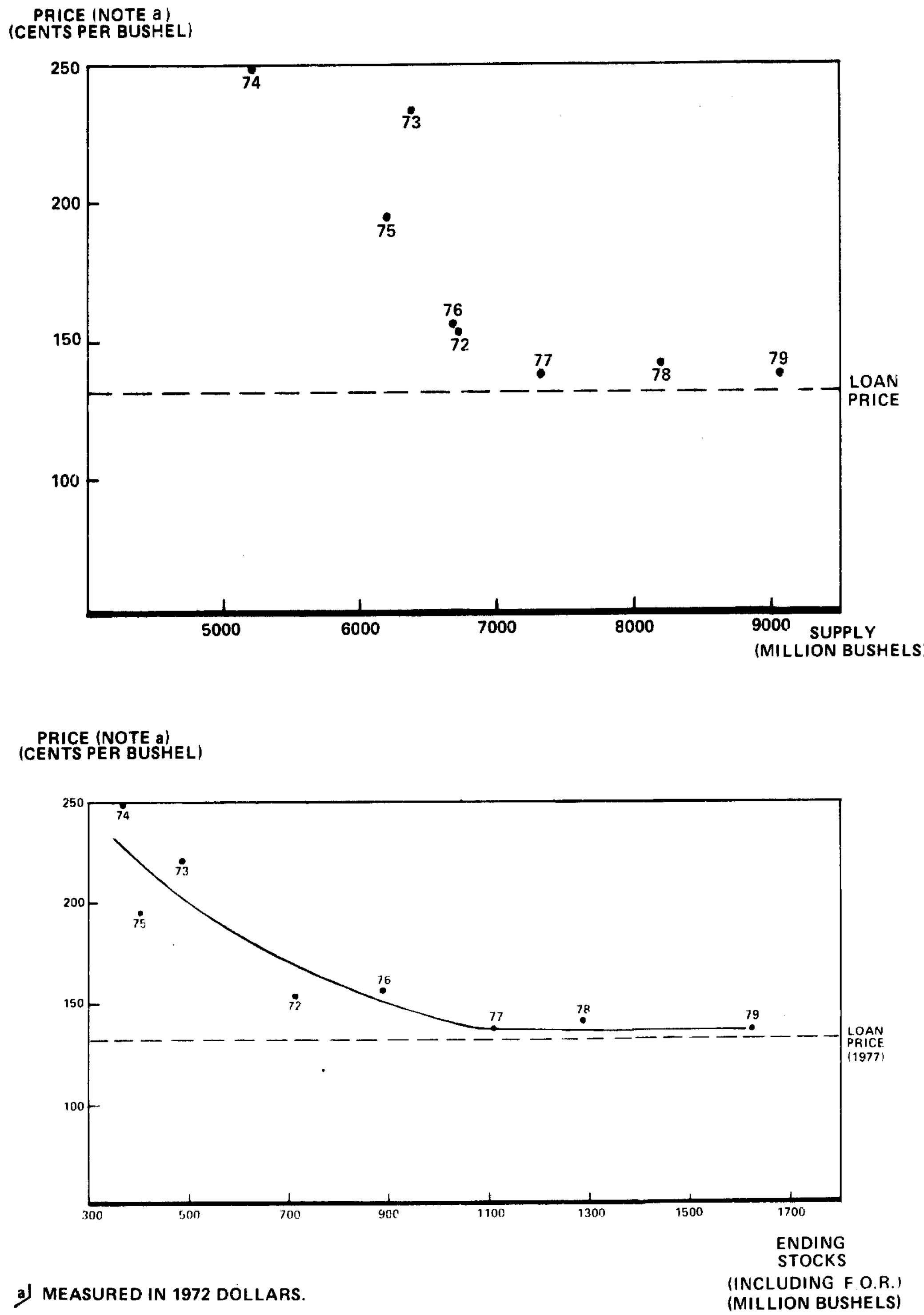




a/ MEASURED IN 1972 DOLLARS.

FIGURE 2A

FARM PRICE OF CORN AS RELATED TO SUPPLY AND STOCKS



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 regression 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 different 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 million bushels of grain per year. Using the estimates from the annual data, this could have increased total stock accumulation by 125 million bushels each year.

The price effect of taking this quantity out of the disappearance 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 release 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 quarterly data, the linkages between the FOR program and stockholding 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 program, 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 promoted 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 estimated earlier, the program could promote stability by increasing 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.

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	-0.94		11	-0.014
		(32.5)	(6.0)		(0.2)	(0.7)
23.	Wheat(2SLS)	0.98	-0.96	0.035		-0.012
		(33.3)	(5.9)	(0.4)		(1.0)
24.	Corn(2SLS)	0.82	-0.60		-75	0.028
		(18.2)	(2.2)		(0.5)	(1.2)
25.	Corn(2SLS)	0.82	-0.71	0.077		0.013
		(17.5)	(2.9)	(0.4)		(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	0.15		-31	0.029
	(3.6)	(1.0)		(0.3)	(0.7)
Wheat	-0.24	0.18	-0.07		0.023
	(3.6)	(1.2)	(0.8)		(1.5)
Corn	-0.07	0.02		-31	0.014
	(5.7)	(0.2)		(0.8)	(1.9)

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

ANALYSIS OF DAILY DATA

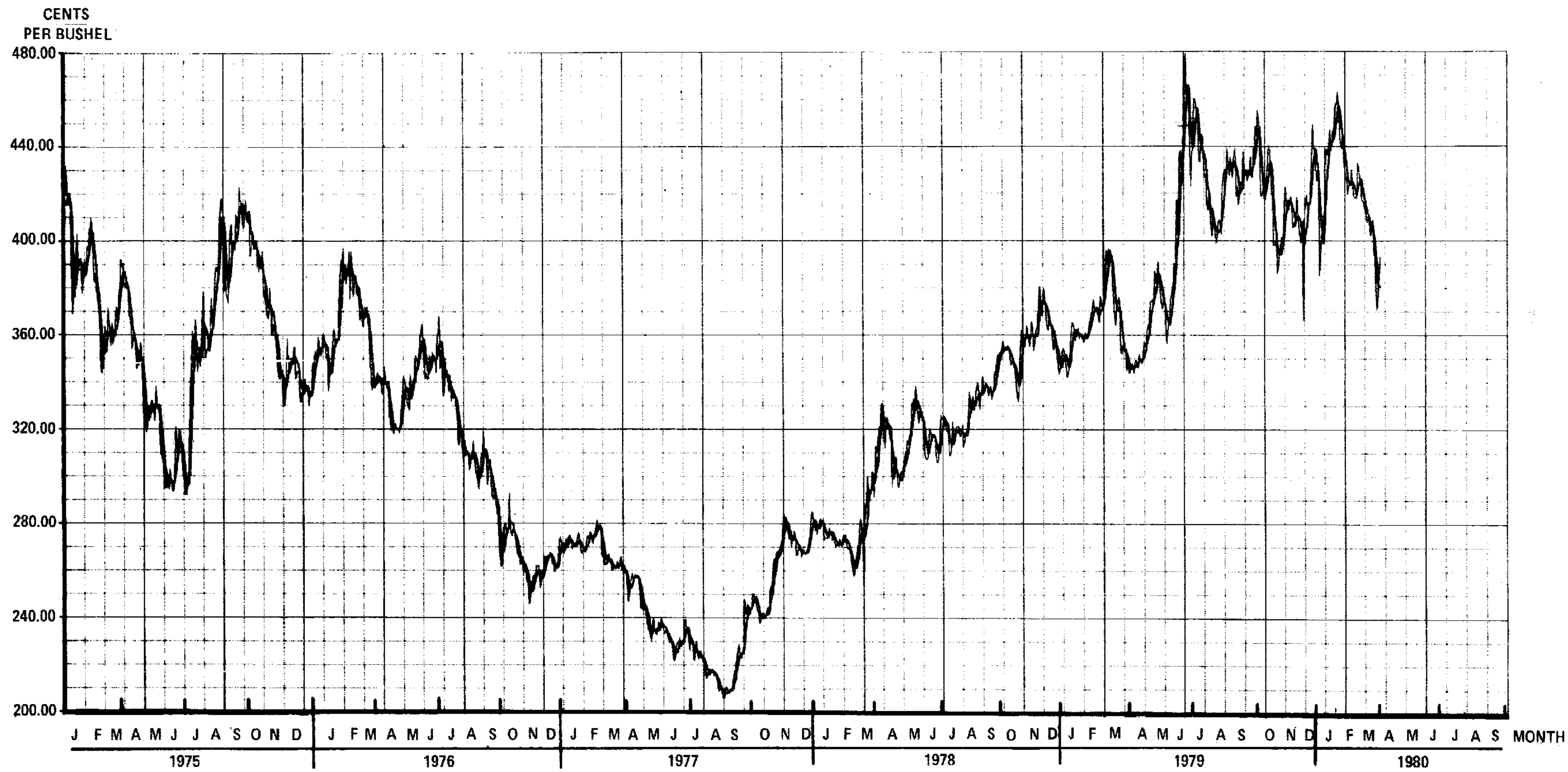
More detailed evidence on grain price behavior under the FOR program can be obtained by examining daily price data. The data for cash corn and wheat at Chicago is shown in figures 3 and 4. Two questions will be considered: first, is the short-term behavior of prices or price variability different following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

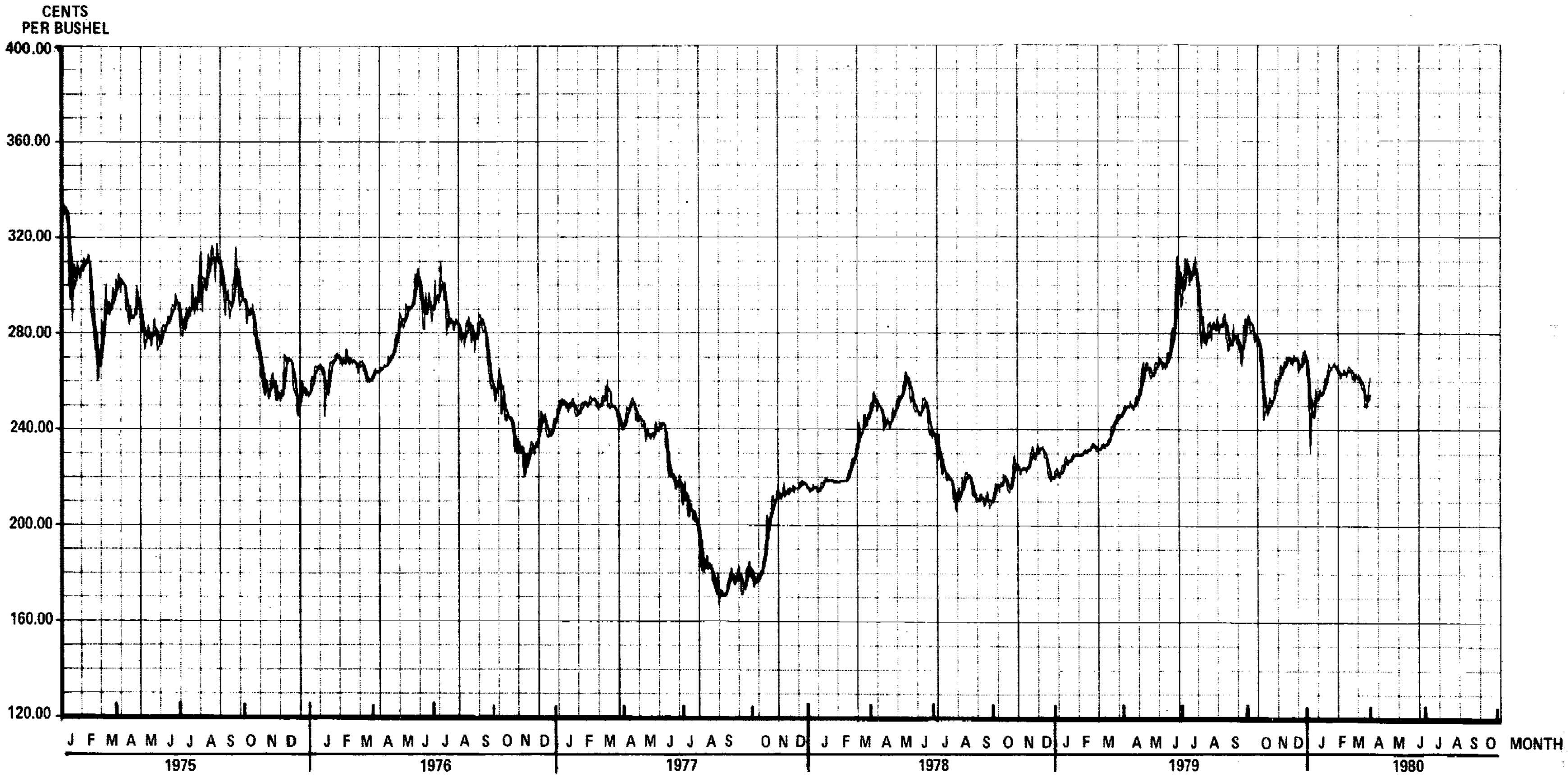
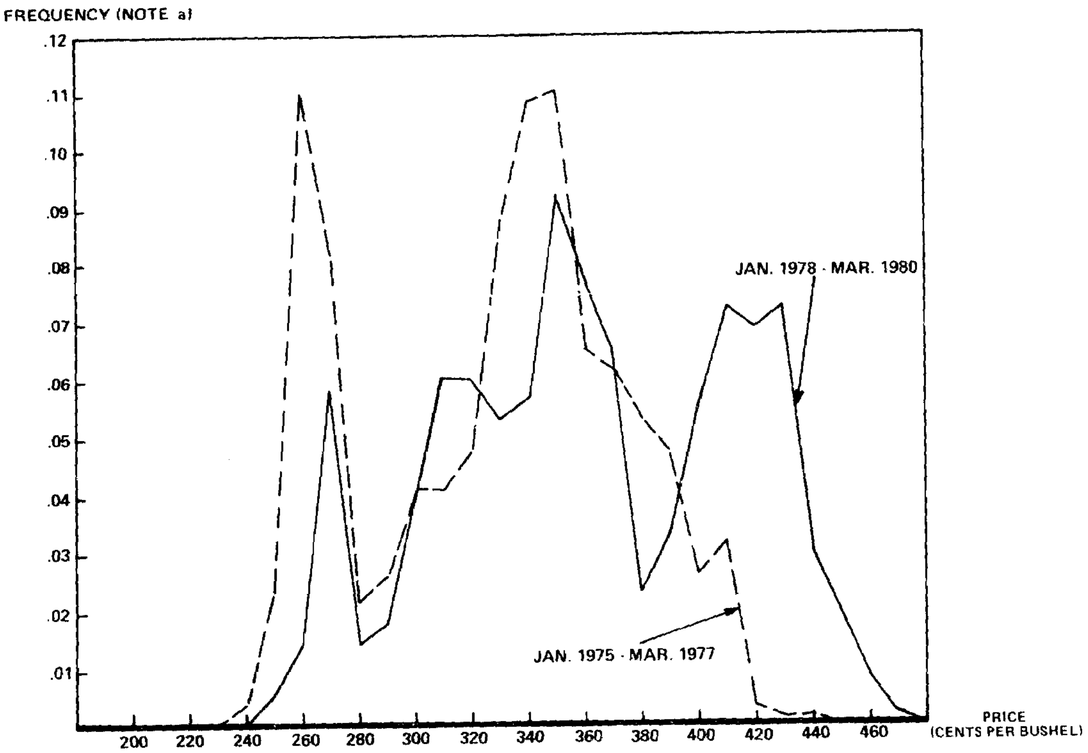


FIGURE 5

WHEAT: DAILY CHICAGO PRICE



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 Government 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 information, 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 coefficient 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

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 holding 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 distribution 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.

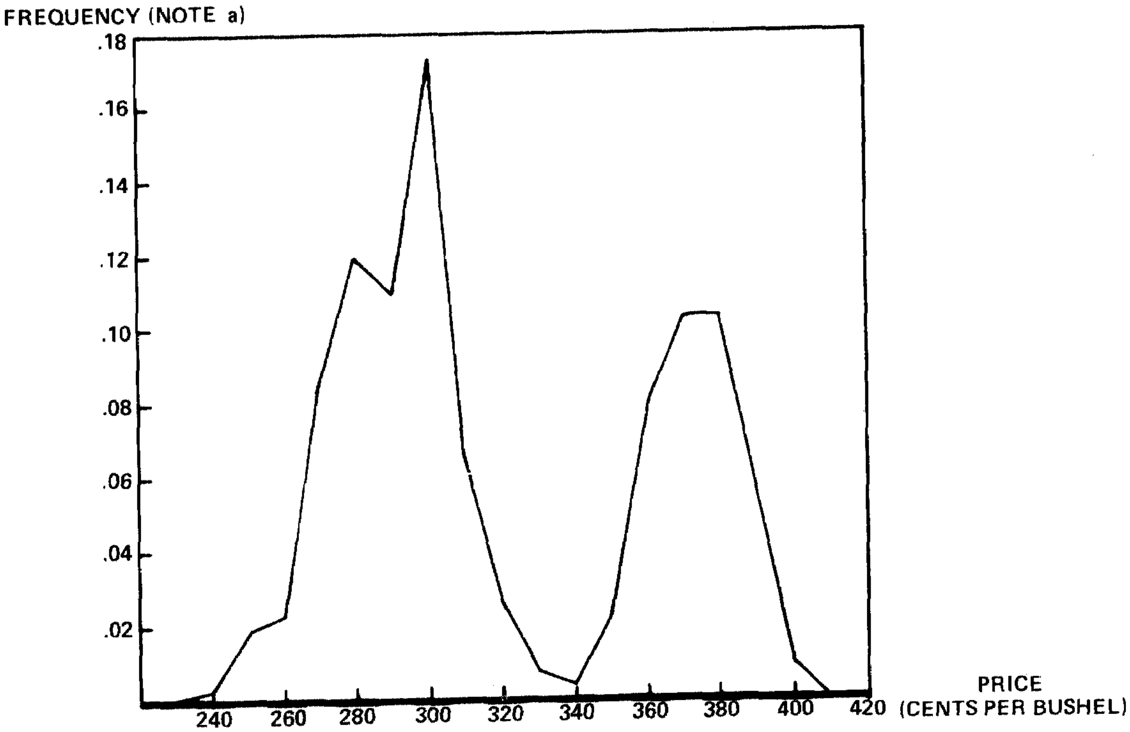
Turning to daily corn prices, the distributions of price as plotted in figure 7 look roughly similar in dispersion in the FOR and pre-FOR periods, although mean price is clearly higher in the pre-FOR period. The standard deviation and coefficient of variation of the daily corn price is slightly greater 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 distributions of daily <u>changes</u> 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

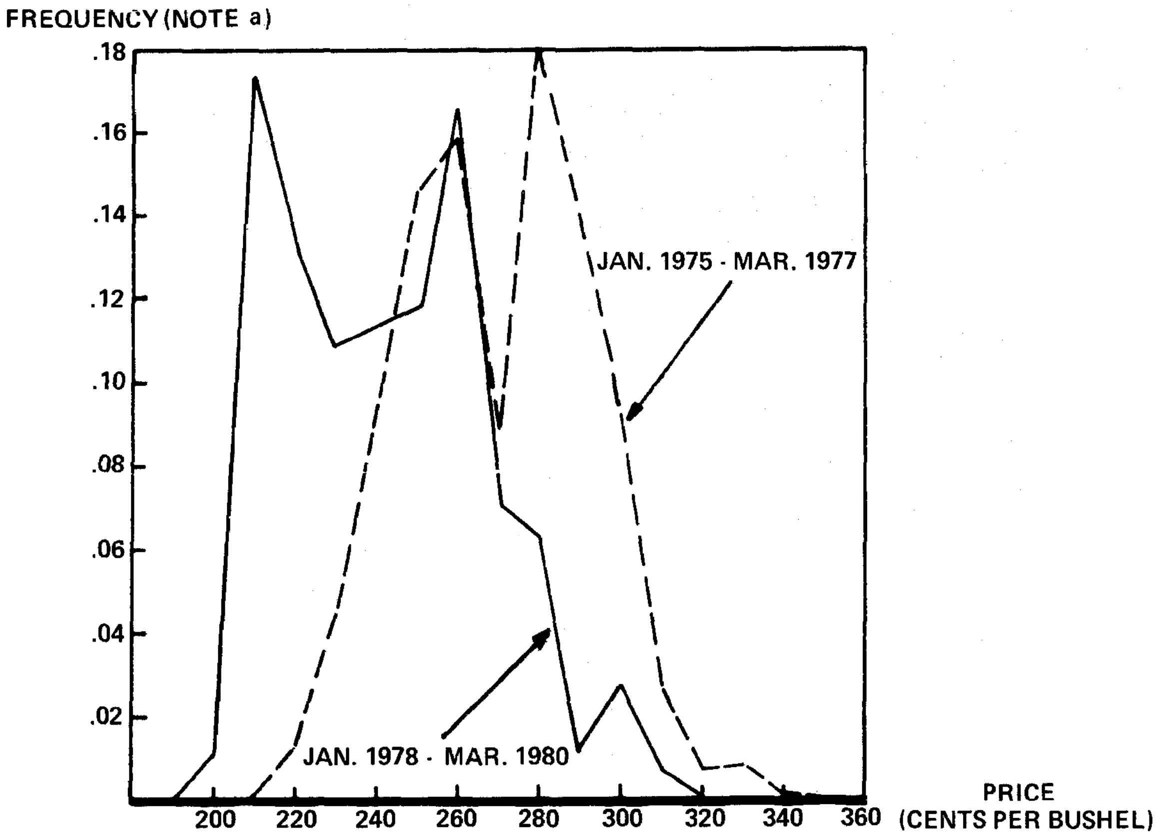
WHEAT: ASCS 5- DAY MOVING AVERAGE PRICE, JAN. 1978-MAR. 1980, ADJUSTED TO FARM LEVEL



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.

FIGURE 7

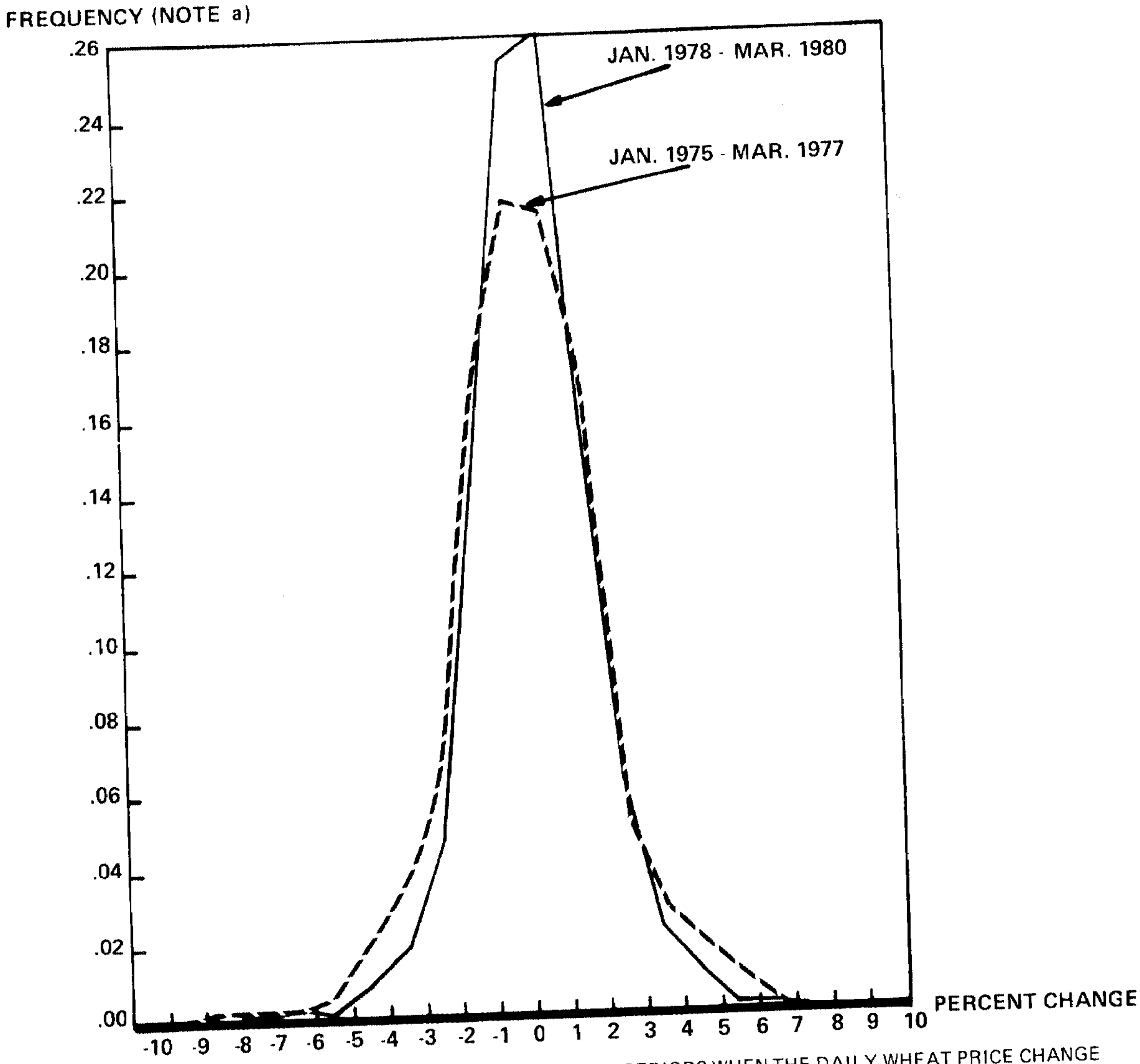
CORN: DAILY CHICAGO PRICE



a/ THE PERCENTAGE OF TIME DURING THE INDICATED PERIODS WHEN THE CLOSING DAILY CORN PRICE WAS IN EACH 10-CENT PRICE RANGE.

FIGURE 8

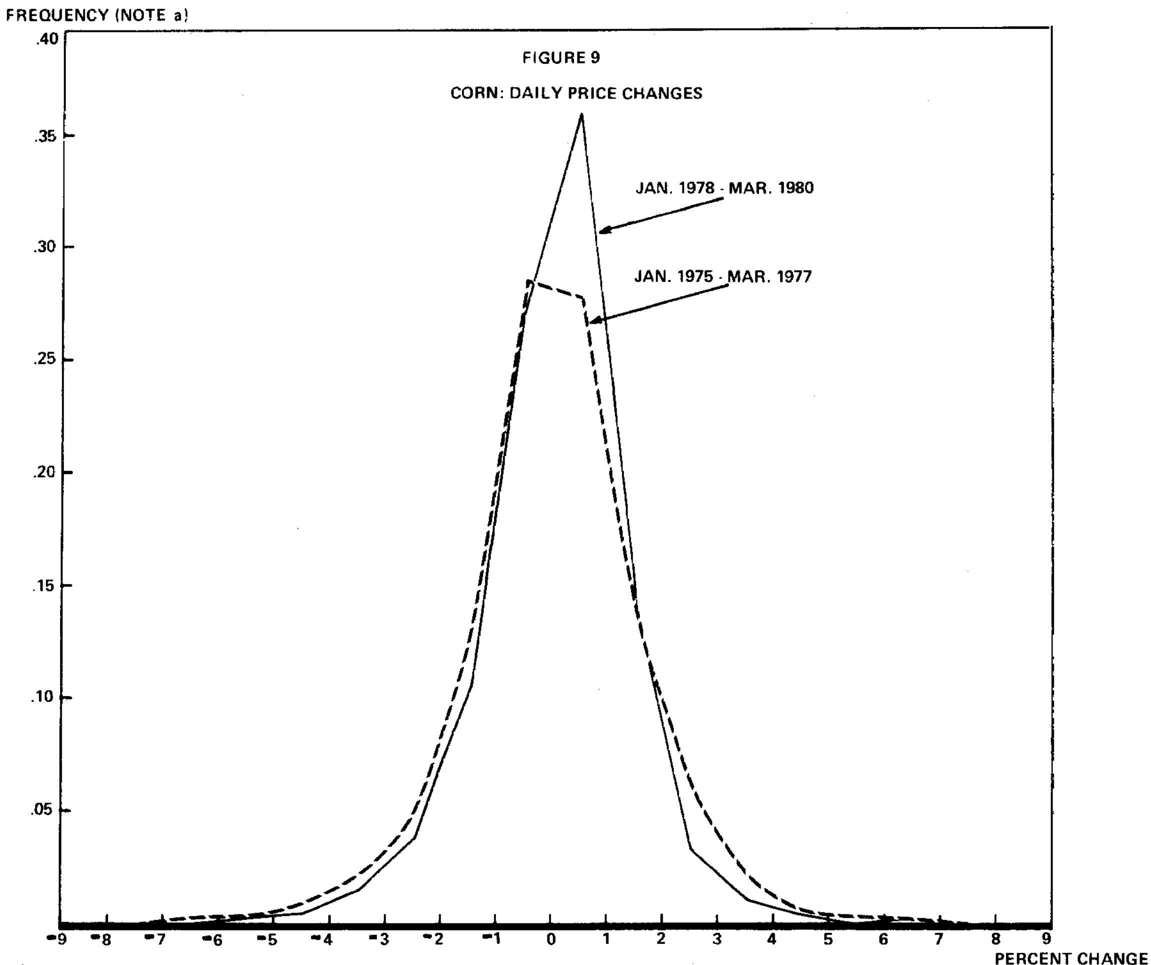
WHEAT: DAILY PRICE CHANGES



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



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

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.

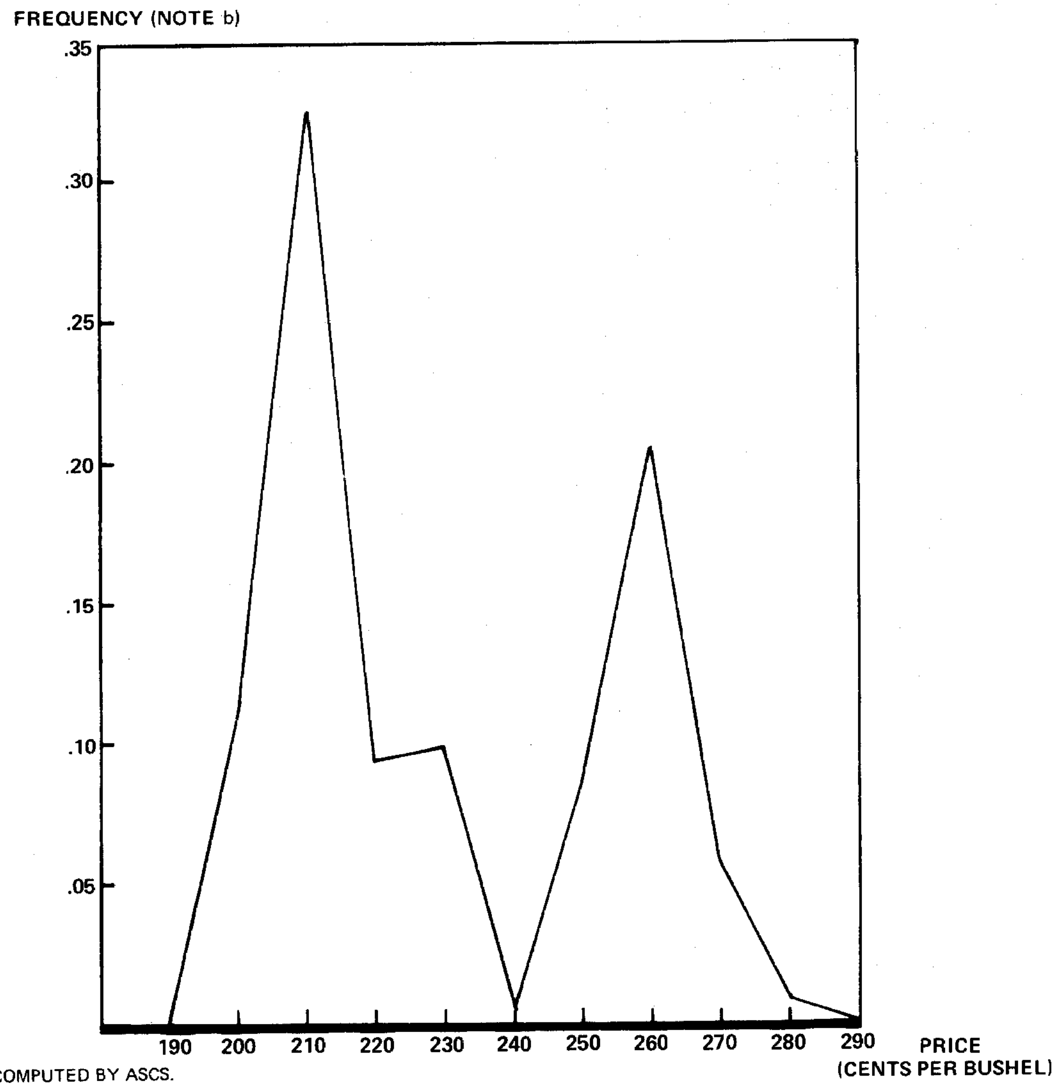
It could be that the absence of unimodal price distributions is primarily due to nonstationarity of the underlying mean price and not to the FOR program. However, the nonstationarity is not due to trends or cycles that standard techniques of statistical time series analysis can remove. A more likely 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)



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 23, 1977	In congressional testimony, wheat FOR program intentions announced.
April 4, 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 15, 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 1978	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 Level (note a)	Wheat Change	Corn Level (note a)	Corn 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 compared 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 deviation of daily price changes is slightly larger in the FOR period is not in itself good evidence that the FOR was destabilizing, because it may have been operating in a fundamentally 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 intentions 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 summary 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 release. 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.

SECTION 7

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:

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

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 Multimarket 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 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.

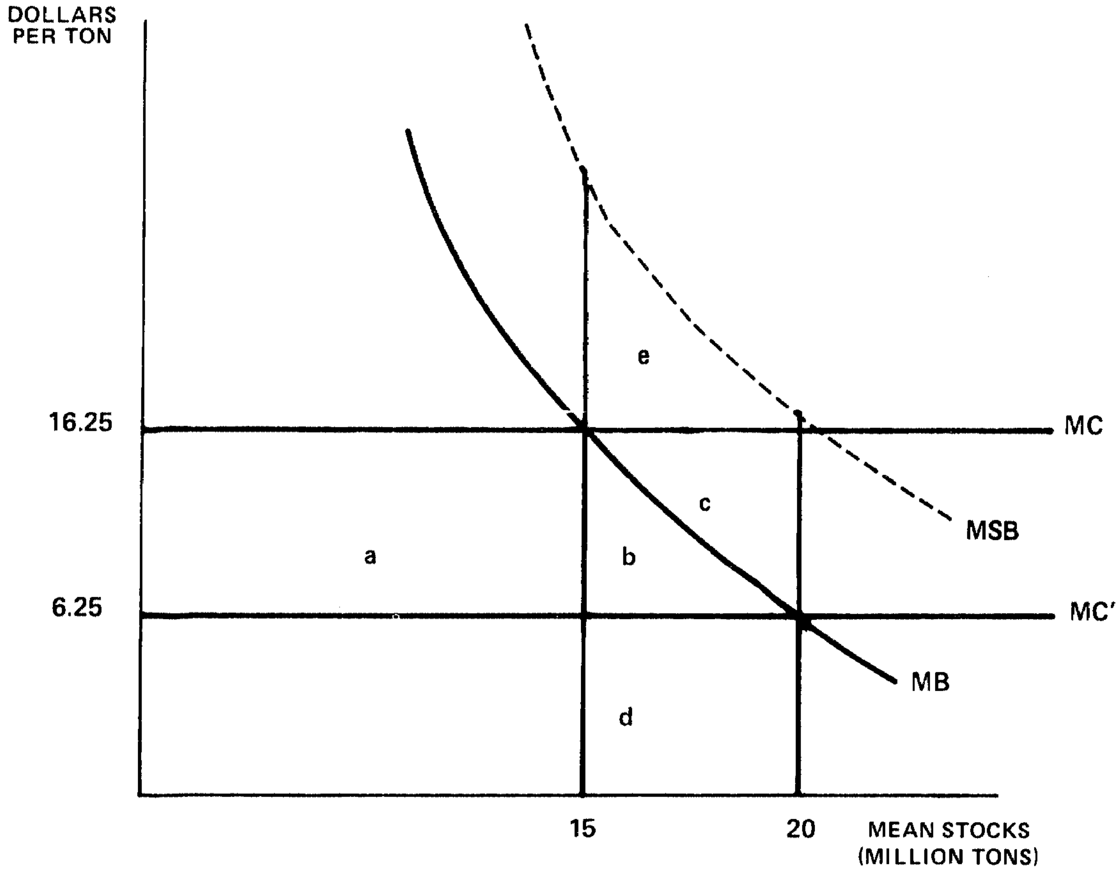
From the point of view of efficient resource allocation, the cost of the FOR is all the resource costs, whether borne by the Government or not, of the net addition to stocks caused by the FOR. The storage facility, handling, and quality-control costs are roughly accounted for in the $10 per metric ton 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



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 Economics," 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 the 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 supplies 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 producers, consumers, and taxpayers jointly. The mechanism for accomplishing this maximization is efficient stabilization. That is, we will assess policy alternatives principally 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 extent 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 following 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 emphasis to boosting farmers' returns, then the FOR (or any other stockpiling program) is inferior to production-control policies, for reasons just stated.

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 stabilization 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 stockholding. 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 stockholding 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 explicitly 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 inferior 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 annually by the same percentage as the GNP deflator. Adjusting for the underlying supply/demand situation is more difficult. It could perhaps be tied to an annual determination such as the Secretary of Agriculture is now required 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.

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 1973-74. A low release price will do relatively little to promote stockholding 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 suboptimal 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 stocks 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.

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Farmer-Owned Grain Reserve Program Needs Modification To Improve Effectiveness: Theoretical And Empirical Considerations In Agricultural Buffer Stock Policy Under The Food And Agriculture Act Of 1977

By Dr. Richard E. Just

Volume 3 Of Three Volumes

Dr. Just's analysis indicates that price stabilization in both the grain and livestock markets due to the farmer-owned grain reserve was minor. The benefits from short-term stabilization were not sufficient to outweigh the related economic costs. As a result, the program led to a net economic loss over the 2-year period of the study, considering all affected market groups.

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PREFACE

GAO and two agricultural economists have reviewed the farmer owned grain reserve program. This volume, written by Dr. Richard E. Just, analyzes the major theoretical developments of stabilization policy and then uses this information to develop a model to investigate the effects of the reserve program on prices, quantities, and real income for grain and livestock markets.

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.
2	Consequences of USDA's Farmer-Owned Reserve Program for Grain Stocks and Prices--examines data on stocks and prices of corn and wheat during the program's first 3 years and estimates its effects.

THEORETICAL AND EMPIRICAL CONSIDERATIONS IN AGRICULTURAL BUFFER STOCK POLICY UNDER THE FOOD AND AGRICULTURE ACT OF 1977

By Dr. Richard E. Just

SUMMARY

This study analyzes the major theoretical developments in stabilization policy, most of which have occurred over the past 10 years. These theoretical developments raise serious questions about most previous empirical work on stabilization policy. Based on generalizations implied by these theoretical studies, a 34-equation, nonlinear simultaneous equation model of the wheat/feed-grain/livestock economy is specified and estimated in this study. The estimated model is then used to investigate the effects of the farmer-owned reserve program on prices, quantities, and real income for grain and livestock markets.

FALSE PRICE SIGNALS RESULTED IN MALADJUSTMENT IN LIVESTOCK INDUSTRY

The empirical results suggest that the program has not benefited grain producers, except for minor benefits in its first year. One reason why the program had few benefits for producers is that large farmer-owned reserves, once accumulated, tended to depress prices because demand for private stocks fell substantially. But this effect may be minor. A more serious drawback is that it gave false price signals to the livestock industry, causing maladjustment. During the program's first year, the relative shortage of grain in the commercial market (compared with what would have been the case without a farmer-owned reserve--not compared with previous years) caused a tendency to higher feed prices and thus contraction in the livestock industry (breeding stock as well as animals on feed) as compared with what would have occurred without a farmer-owned reserve. Later, as the reserve was filled and the grain market could have returned to normal levels, the demand for feed was lower because the livestock industry had held back on production, and thus grain prices tended downward. This grain price effect continued for some time because of the long timelag required to adjust herd sizes and produce feeder animals. These results suggest that substantial economic imbalances can result from frequent policy changes for which the effects cannot be well anticipated.

Results imply that over the first 2 years of the farmer-owned reserve program as a whole, grain consumers and livestock producers generally benefited while meat consumers and grain producers did not. Grain market gains generally exceeded meat market losses for consumers. More importantly, grain producers' losses outweighed the gains of all groups combined. Most of this loss apparently was due to indirect effects of maladjustments caused by temporary false price signals early in the program.

These results suggest that frequent changes in agricultural policy are costly. An agricultural policy should be able to adjust automatically over the long term to changing economic conditions without causing unexpected changes in loan rates, set-aside requirements, etc. This study suggests an alternative policy that may meet these needs.

PROGRAM APPEARS TO HAVE STABILIZED SHORT-TERM GRAIN PRICES

Results indicate that the program helped to stabilize prices in both grain and livestock markets. This conclusion is also supported by an analysis of the effect of an unexpected market development--the Russian grain embargo.

However, the results indicate that the benefits from reducing short-term instability (unanticipated price variations one quarter ahead) are minor compared with the overall losses discussed above. Furthermore, the econometric analysis shows that economic benefits of stability may not be large because producers do not have a strong preference for stable incomes in the short run (one quarter ahead). On the other hand, longer term price stability can prevent the kind of industry maladjustment that occurred as a result of the reserve program. Therefore, long-term stability has much greater economic benefits. But this type of stability cannot be attained with frequent revisions of policy and, in fact, long-term stability does not appear to have been an important objective of U.S. agricultural policy.

GOVERNMENT OWNERSHIP APPEARS TO BE MORE EFFECTIVE THAN FARMER OWNERSHIP

The results of this study strongly favor Government (Commodity Credit Corporation--CCC) ownership over farmer ownership of the grain reserve to the extent that a purpose of the reserve is to meet emergency needs. Apparently, private market concerns regard the farmer-owned reserve as a close substitute for private stocks. Because the reserve is farmer controlled, it can be more responsive to market developments than a CCC-owned stock. Also, farmer-owned reserves will more likely reenter market channels than CCC stocks, which are often used for foreign assistance outside commercial channels. Finally, farmer-owned reserves are more likely held by the same individuals who would otherwise hold market stocks. As a result, the Government pays storage costs on a large part of the reserve that would otherwise be stored by private concerns. Estimates show that over 80 percent of the farmer-held reserve for wheat and over 50 percent for corn would be held in absence of Government payments for storage.

If the Government held the reserve stock, its costs could be cut almost 80 percent for wheat and 50 percent for corn for the same level of protection afforded by the farmer-held reserve program. This result further suggests that the large farmer-owned reserve levels may be providing a false sense of security for policymakers. If much of the farmer-owned reserve is regarded as a substitute for market stocks by those who control sales decisions, then the amount actually available for emergency purposes is far less (about 80 percent less for wheat) than if a similar level of stocks were held by CCC. The reason for this conclusion is that estimates show CCC stocks are not regarded as a close substitute for market stocks; hence, when Government stocks are held by CCC, market stocks are not reduced by a corresponding amount and thus more grain is available for emergency purposes.

In summary, the results of this study suggest that the stabilizing effect of the program has been minor, that major economic inefficiencies resulted from temporary price effects at program inception, and that the particular mechanism of reserve accumulation--the farmer-owned reserve--uses Government funds inefficiently. If a stabilization program is used at all, it should apparently be based on CCC storage and have a built-in mechanism to ease the transition at program inception and should allow producers to better anticipate policy adjustment to market developments and thus make better investment decisions.

While these results are subject to errors of estimation and specification (as in any econometric study)--particularly since only 2 years of data were available in the farmer-owned reserve period--the results at least suggest skepticism regarding net benefits because a reasonably specified model with plausible estimates indicated large negative effects. Furthermore, some experimentation with model specification has suggested that most of the results of this study are quite robust unless specifications are constrained to follow traditional, nonflexible functional forms.

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SECTION 1

INTRODUCTION

The purpose of this study is to review and evaluate theoretical concepts relating to buffer stock policy in the agricultural economy and to consider implications for empirical evaluation of the reserve policy under the Food and Agriculture Act of 1977 on the various major agricultural sectors in view of these theoretical results. The latter analysis focuses specifically on producers of wheat, feed grains, beef, hogs, and poultry and on consumers.

The effects of the policy are evaluated using the concept of economic surplus. Economic surplus is defined as the real income or net benefit derived by producers or consumers from participating in a particular market. With simple concepts of supply and demand, one can readily estimate the effects of a policy on prices and market quantities, but some additional measure of economic welfare is needed to determine whether such changes are beneficial or not (and by how much) for each group of producers and consumers. For example, the amount of a price increase multiplied by the quantity a consumer was consuming before the price increase generally overestimates the change in his real income; he may be better off by consuming less and diverting some expenditure to goods which were almost preferred before the change. The concept of economic surplus accounts for these possibilities in the case of both producers and consumers. In this sense, this study may be regarded as a cost-benefit analysis of the reserve policy enacted by the Food and Agriculture Act of 1977 (although administrative costs are not considered).

Changes in economic surpluses measure changes in real income for market participants. The theory of economic welfare has shown that economic surplus or real income changes can be calculated using consumer demand and producer supply curves. 1/ One can view a demand curve as specifying the maximum amount that a consumer is willing to pay for each additional unit of a product. For example, in figure 1, p2 is the maximum price that a consumer would pay for an additional unit of consumption if he were already consuming q2. Thus, if a consumer actually pays price p1 for every unit of the product, then he has an excess

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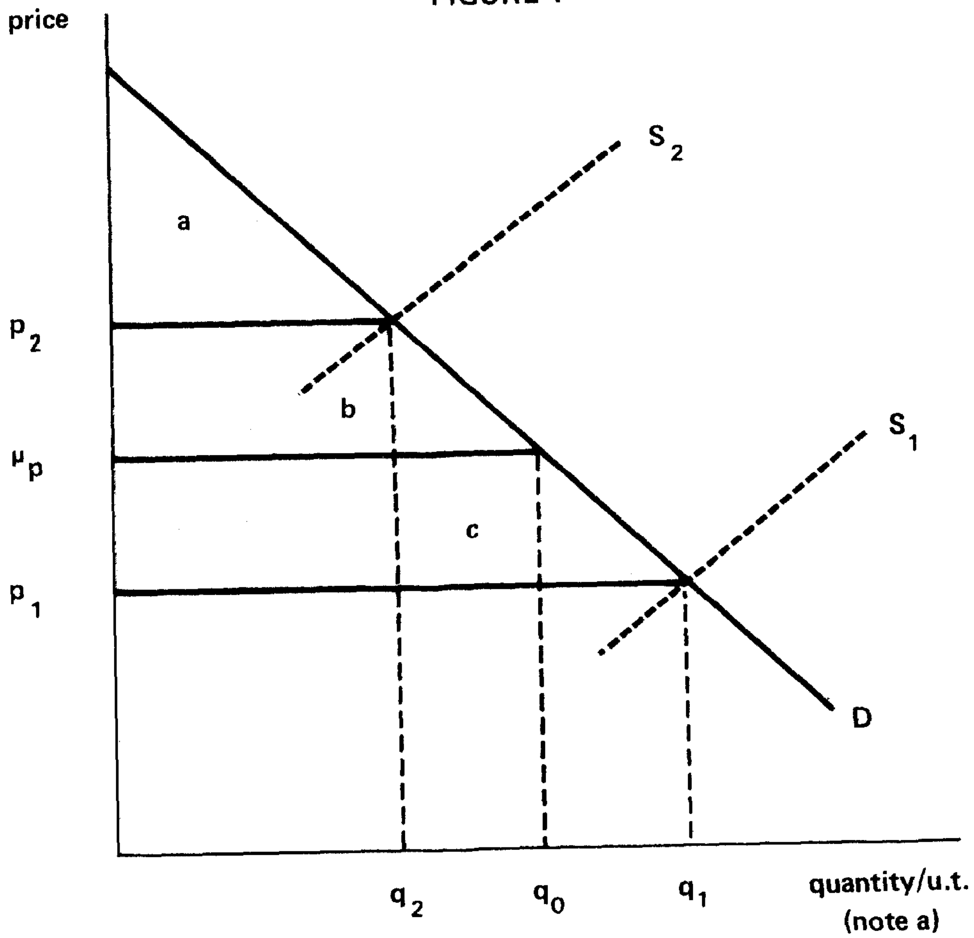
1/M. Currie, J. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," Economic Journal, Vol. 81 (1971), pp. 741-799.

FIGURE 1



a/Quantity per unit of time.

willingness to pay given by the vertical distance between pl and the demand curve for each unit of output to the left of ql. Summing this excess willingness to pay over all units of output purchased at price pl (i.e., between zero and ql) obtains the area a as a measure of the consumer's benefits or real income associated with consuming quantity ql at price pl. Therefore, the change in area below a demand curve and above price measures the change in real income that a consumer derives from participating in a market. 1/ The significance of this area, sometimes called consumer surplus, readily extends from the individual consumer level to the market level.

Parallel developments on the supply side have also shown that a supply curve measures willingness to sell. Hence, the area above a supply curve and below price measures producers' excess willingness or real income. The change in this area, sometimes called a producer surplus change, has been shown to measure change in short-run profits for producers. 2/ Furthermore, the change in area below a producer's derived demand curve and above price measures changes in short-run profits for the associated producer.

The major weakness of the economic surplus approach is the partial nature of its application in practice; that is, it has tended to be applied in single markets without due consideration of effects in other markets. However, a number of recent generalizations have increased the possibilities for more general application where related economic welfare implications in other sectors are also considered. 3/ The principles of these developments

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1/Technically, this relationship holds only for a compensated demand curve, but R.D. Willig has shown that the same result holds with a high degree of approximation under a wide range of conditions for an ordinary demand curve such as is estimated from market data. See R.D. Willig, "Consumer's Surplus Without Apology," American Economic Review, Vol. 66 (1976), pp. 589-597.

2/E.J. Mishan, "What is Producer's Surplus?," American Economic Review, Vol. 58 (1968), p. 1279. Note that the term "short-run profits" is technically called "quasirents."

3/R.E. Just and D.L. Hueth, "Welfare Measurement in a Multimarket Framework," American Economic Review, Vol. 69 (1979), pp. 947-954, or at a more comprehensive level, R.E. Just, D.L. Hueth, and A. Schmitz, Applied Welfare Economics and Public Policy, New York: Prentice Hall, 1981.

are followed in the applied portion of this study by considering extended effects of grain market policy specifically in livestock markets for cattle, hogs, and poultry at both the farm and retail levels. In addition, the welfare effects on farm input suppliers are also considered implicitly to the extent that estimated farm supply curves take into account correlated input price variations. 1/

With these concepts in mind, the following discussion focuses on the effects of reserve policy not only on market prices and quantities, but also on the real income of agricultural producers and consumers. The following section begins by evaluating the theoretical case for reserve policy. Are economic gains from reserve policy conceivable and which economic groups are made better off as a result? A basic model is first expounded. Then a number of recent theoretical considerations which lead to major revisions of these results based on particular market characteristics are discussed in sections 3 through 7.

This survey of theoretical considerations concludes that even though overall gains may be possible, economic theory alone cannot determine whether or not any particular sector of the agricultural economy other than Government will gain or lose as a result of a reserve policy. (See sec. 8.) However, these theoretical results point out some crucial generalities which must be considered in evaluating reserve policy. Since nearly all previous empirical evaluations of reserve policy have not considered these generalities, their results are not reliable. The imposed empirical specifications are so rigid that the data is not allowed to suggest some plausible outcomes of even the qualitative distribution of benefits (that is, outcomes suggesting which sectors of the agricultural economy gain and which lose with reserve policy).

Based on necessary generalities suggested by theoretical considerations, section 9 develops and estimates a model of the wheat/feed-grain/livestock economy which can be used in investigating effects of the reserve policy. Because the generality required for evaluating reserve policy in view of the theoretical considerations of this study surpasses that used in almost all previous studies, no previous estimates exist for some of the parameters. Thus, the econometric model developed here is a departure from previous precedent in terms of functional form. But as

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1/This result is proven in Just and Hueth, *op. cit.*

shown by the theoretical results, this additional generality is necessary before results can be considered valid.

Section 10 uses this model to evaluate the effects of the reserve policy of the Food and Agriculture Act of 1977 on the various sectors of the agricultural economy. Section 11 further evaluates the ability of the farmer-owned reserve to smooth unexpected market shocks in the case of the Soviet grain sales embargo of 1980 as a case in point. Section 12 summarizes conclusions about how effectively the farmer-owned reserve has met the goals and objectives of the policy. Finally, section 13 examines implications of the results for future agricultural policy design.

SECTION 2

THE CASE FOR RESERVE POLICY AND BUFFER STOCK HOLDINGS

The welfare effects of price instability were first studied by Frederick V. Waugh in 1944. 1/ He concluded that contrary to popular opinion, consumers should prefer price instability. His results are developed in figure 1 where D represents demand and consumers face prices p1 and p2, each of which occurs half the time, i.e., with probability 0.5. These price variations may be caused by random fluctuations in supply between S1 and S2. When price is p1, consumers buy q1 so that consumer real income (surplus) is represented by area a + b + c. When price is p2, consumers buy q2 so that consumer real income is represented by area a. On the other hand, if prices are stabilized by a Government policy at the average price level, $\mu p = (p1 + p2)/2$, then consumption takes place at q0 with consumer real income represented by area a + b.

To investigate the welfare effects of price stabilization, note that half the time consumers gain area b as price is lowered from p2 to μp, but the other half of the time consumers lose area c as price is raised from p1 to μp. Since $p2 - \mu p = \mu p - p1$, the loss obviously outweighs the gain; the average loss is 1/2 (area c - area b). This result implies that consumers prefer price instability if they can take advantage of it by buying more at low prices and less at high prices.

The effect of stochastic output price on producers was first examined in 1961 by Oi. 2/ Assuming a fixed supply curve, he concluded that producers also prefer price instability when they can adjust instantaneously to price changes. To understand his results, consider figure 2 where supply is represented by S and producers are confronted with two prices, p1 and p2, each of which occurs with probability 0.5. These price variations may be caused by random variation in demand between D1 and D2. When

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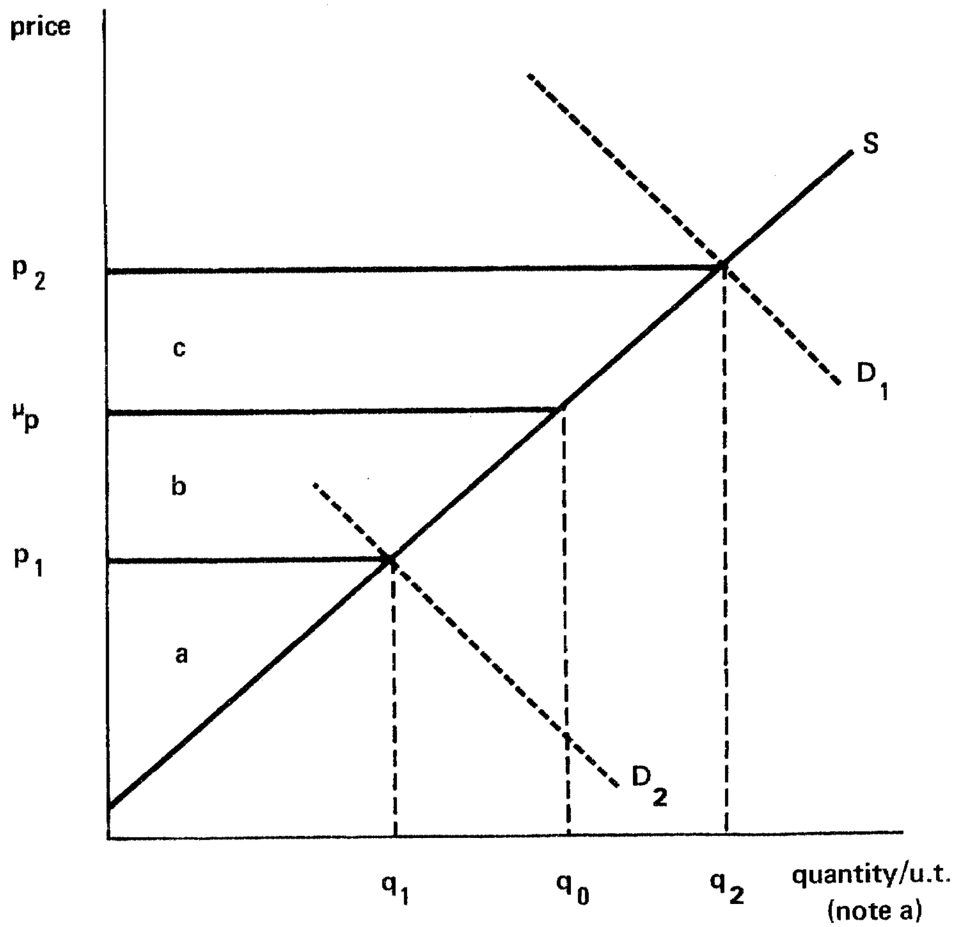
1/Frederick V. Waugh, "Does the Consumer Benefit from Price Instability?," Quarterly Journal of Economics, Vol. 58 (1944), pp. 602-614.

2/W.Y. Oi, "The Desirability of Price Instability Under Perfect Competition," Econometrica, Vol. 27 (1961), pp. 58-64.

FIGURE 2



a/Quantity per unit of time.

price is p1, producers sell q1 so that producer real income (surplus) is represented by area a. When price is p2, producers sell q2 so that real income is represented by area a + b + c. On the other hand, if prices are stabilized by some means such as Government policy at the average price level $\mu p = (p1 - p2)/2$, then production is q0 and producer welfare is represented by area a + b. Where price would otherwise be p1, producers gain area b and where price would otherwise be p2, producers lose area c with stabilization. Since $p2 - \mu p = \mu p - p1$, the latter loss is larger than the former gain; and since each occurs half the time, producers lose on average from price stabilization (unless supply is completely inelastic).

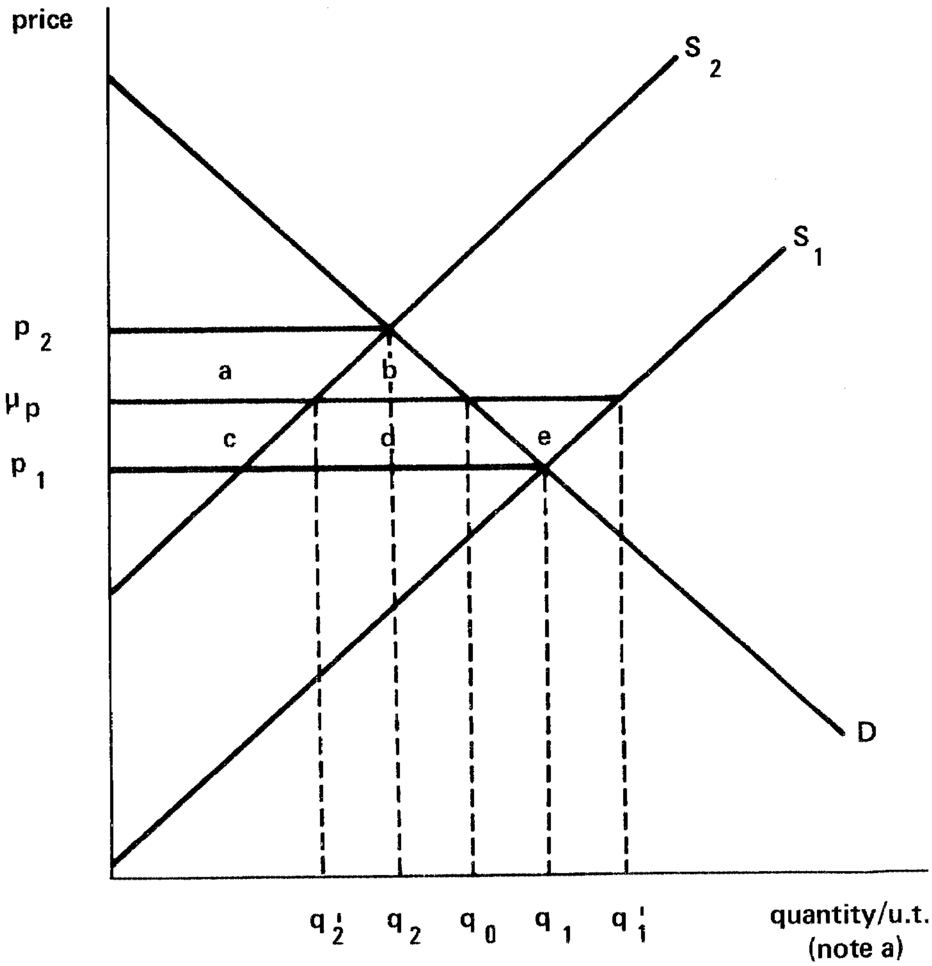
These two counterintuitive results (that an unstable economy is preferable) led economists to consider the issue of price stabilization more closely. Professor Samuelson argued that in fact, an economy cannot "pull itself up by the bootstraps" by simply generating instability. 1/ Both Samuelson and Massell 2/ showed that these two results cannot be simultaneously applicable and that when effects on both sides of the market are considered, there is a net gain from stabilization.

Considering the Massell approach, suppose that in figure 3 consumer demand is represented by D and that stochastic supply is represented by S1 and S2, each of which occurs in alternating periods. Thus, equilibrium prices are p1 and p2, respectively, in alternating periods. Now suppose prices are stabilized at μp, say, by means of a buffer stock policy which buys excess supply, q1' - q0, when S1 occurs and sells excess demand, q0 - q2', when S2 occurs. In the event of S1, consumers thus lose area c + d while producers gain area c + d + e for a net gain of area e. In the event of S2, producers lose area a but consumers gain a + b for a net gain of area b. The average overall effect of price stabilization with such a reserve policy is thus a gain of 1/2 (area b + area e). This result implies that the loss from stabilization for consumers offsets some of the gain for producers who are benefited by stability. Furthermore, the gain for producers more than offsets the consumer loss.

1/ Paul A. Samuelson, "The Consumer Does Benefit from Feasible Price Stability," Quarterly Journal of Economics, Vol. 86, No. 3 (1972), pp. 476-493.

2/ B.F. Massell, "Price Stabilization and Welfare," Quarterly Journal of Economics, Vol. 83 (1969), pp. 285-297.

FIGURE 3



a/Quantity per unit of time.

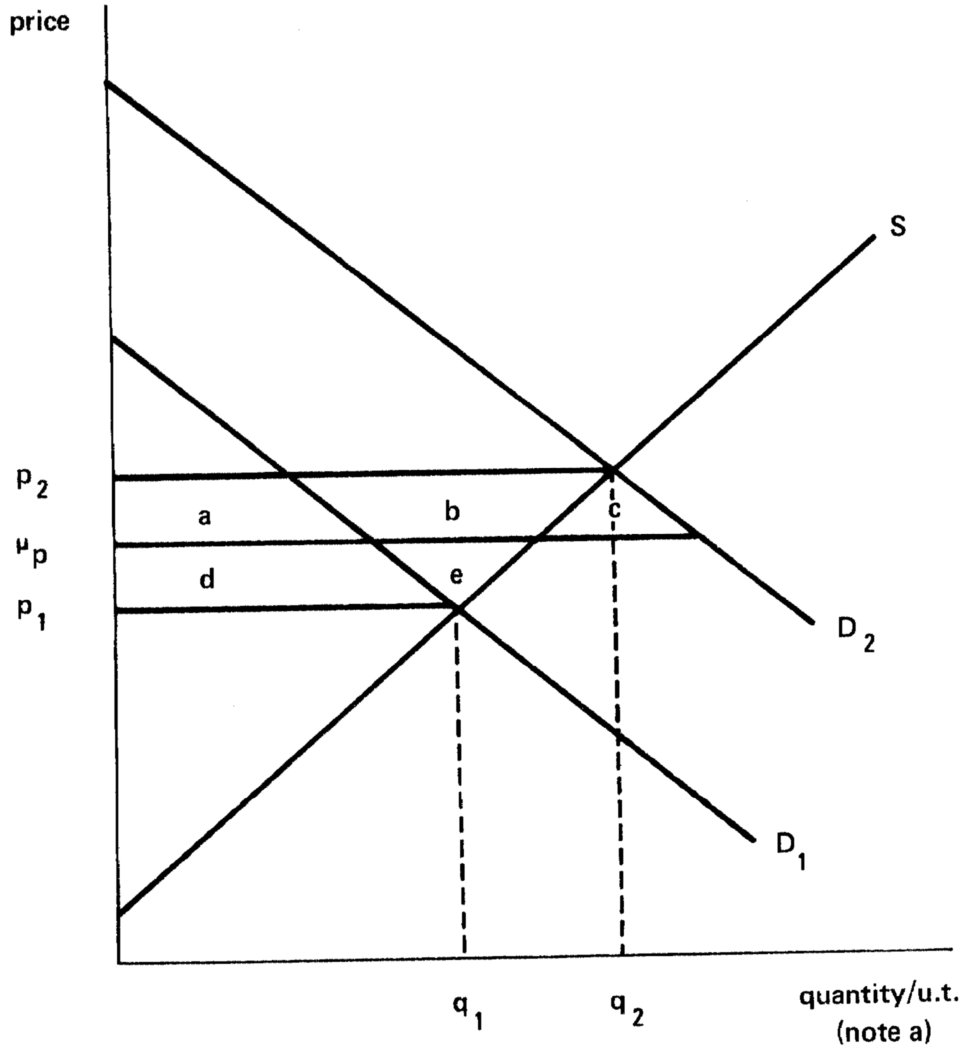
Similar considerations apply to the results in figure 2 as demonstrated in figure 4. With instability represented by demand and price varying between D1 and p1 and D2 and p2, respectively, price stabilization at μp via a buffer stock leads to a gain of area e if D1 occurs or of area c if D2 occurs. On average, the producer loss of 1/2 [area (a + b) - area (d + e)] is more than offset by a consumer gain of 1/2 [area (a + b + c) - area d].

The results of this section suggest that both producers and consumers can benefit by stabilizing prices of storable commodities through a reserve policy if storage costs are not excessive. That is, if one group gains more than the other loses, then a compensation scheme must exist so that both are better off under stabilization.

Massell has further shown that these results can be readily extended to the case with positive storage costs. Consider, for example, figure 5 where supplies S1 and S2 occur in alternative years and where demand is given by D. Corresponding free market prices are thus p1 and p2. Now suppose a reserve policy is instituted such that the buffer stock is increased by q4 - q3 when S1 occurs and is reduced by q2 - q1 when S2 occurs (where q4 - q3 = q2 - q1). The prices p1' and p2' thus correspond to supplies S1 and S2, respectively. Now suppose q4 - q3 and q2 - q1 are chosen such that p2' - p1' is the unit cost of storage. The storage costs are just covered by the buffer stock carriers who buy at price p1' and sell at price p2'. In years of high supply, producers gain area c + d + e over the free market case while consumers lose area c + d; this implies a net gain of area e. In years of low supply, producers lose area a while consumers gain area a + b over the case with no buffer stock; the net gain is area b. As one can see, this analysis and its conclusions are not substantively different than suggested by figure 3. Similar arguments apply to the case of figure 4.

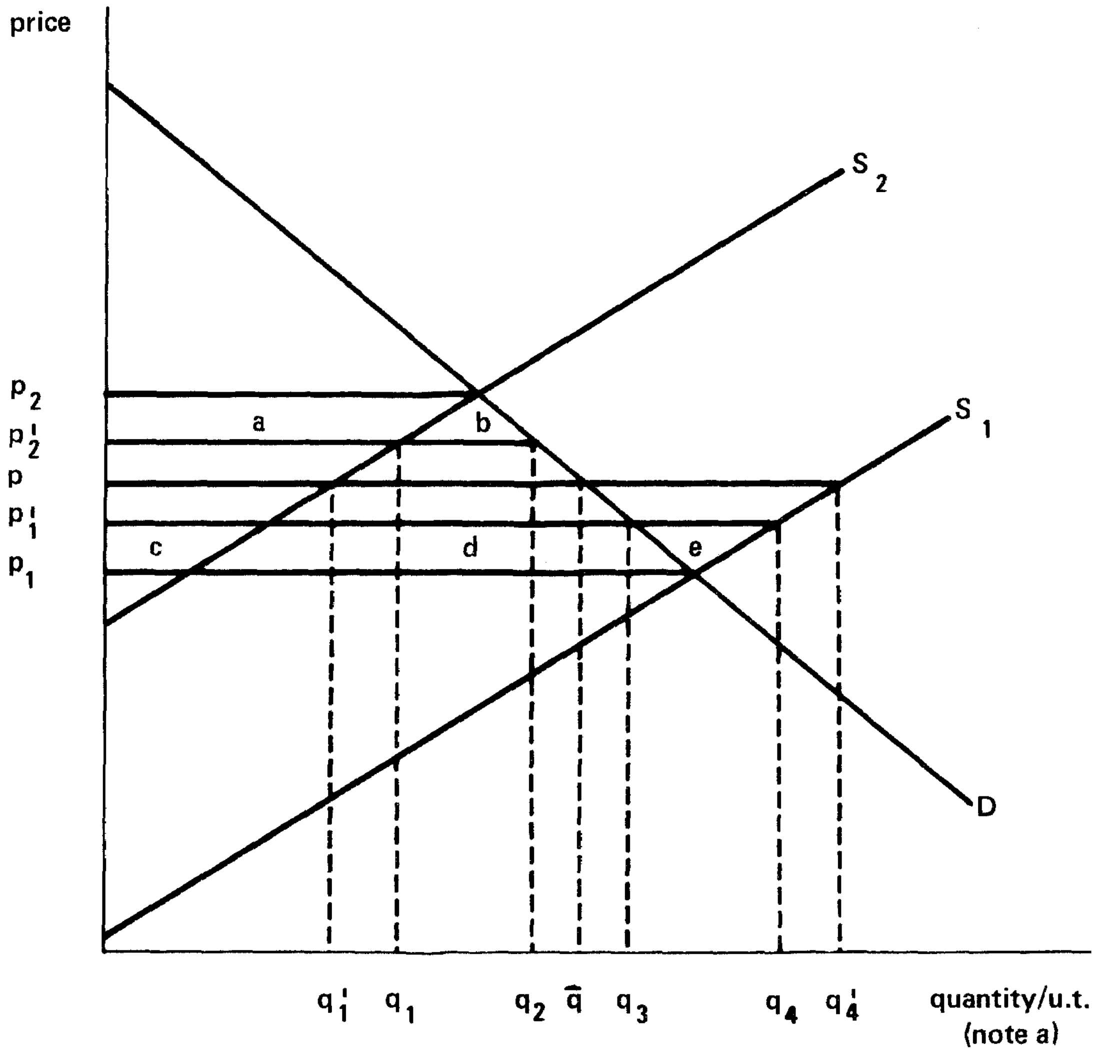
The reserve policy depicted in figure 5 is sometimes called a price band policy because it has lower and upper trigger points which tend to keep prices within the price band defined by p1' and p2'. It is interesting to note some important similarities between price band policy and the current reserve policy. The loan rate at which prices are supported for producers roughly corresponds to p1' since it represents a point at which Government (the buffer stock authority), in effect, will buy all new production (from eligible producers). As excess supply at that price goes into storage under Government control, prices supposedly will not fall below the loan rate.

FIGURE 4



a/Quantity per unit of time.

FIGURE 5



a/Quantity per unit of time.

Then if supplies fall and demand increases, prices may increase. Producers do not dump stocks under Government loan until price reaches the release level. The Government then forcibly divests itself of stock interests if price rises above the call level. Although producers may still hold grain above call level prices, they must do so at their own expense and risk and therefore the free market supposedly prevails. Thus, both the release and call levels correspond in a way to the upper bound of the price band, p2' in figure 5, depending on whether producers tend to unload stocks at their first opportunity (the release level) or whether they tend to hold stocks until the Government forces repayment of loans (the call level).

The Massell analysis suggests that the current reserve policy could improve overall economic welfare. (The spread between loan rate and release levels seems sufficient to cover storage costs.) But whether or not consumers or producers gain from the reserve policy depends on whether demand is more variable than supply. If supply (and factors affecting supply for consumption, such as export demand) is more variable, then consumers tend to be worse off (in figure 3 consumers' loss of area c + d exceeds their gain of area a + b while in figure 4 their gain of area a + b + c exceeds their loss of area d). Also, since the buffer stock authority (the Government) bears the cost of storage without benefiting by selling stocks at a higher price than at which they are accumulated, the taxpayers lose an amount corresponding to storage costs (including the cost of capital tied up in stocks) plus administrative costs. Producers, who receive storage costs as a subsidy plus the additional benefits suggested by figure 5 when supply is relatively more variable than demand, appear to be the beneficiaries of the reserve policy. 1/

The Massell analysis may be interpreted in yet another way considering the importance of international markets for U.S. grain. This interpretation, suggested by Hueth and Schmitz, views the exporting country as the supplier and

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1/Note that the present arguments assume for purposes of discussion that the stochastic distribution of prices is symmetrical and centered around the effective price bands. This assumption will be relaxed for the empirical analysis.

the importing country as the demander. 1/ In this case, the demand may be considered more variable than supply in light of events in the 1970s. If so, then it could be that the major beneficiaries of U.S. reserve policy are importers of U.S. grain. U.S. producers may still benefit to some degree, but this benefit may be solely or completely at the expense of U.S. taxpayers and consumers. In the latter case, an alternative transfer program between domestic producers and consumers that does not also transfer real income to U.S. grain importers may be more beneficial.

The results discussed in this section represent the state of the art that prevailed in theoretical analysis of stabilization policy until about 1976. Ensuing literature, however, has shown that the above conclusions about who gains and who loses from price stabilization are highly sensitive to shape, movement, and other aspects of specification regarding demand and supply. Some of the more important considerations have to do with (1) nonlinearity, (2) the form of random disturbance, (3) private storage response to public intervention, (4) risk aversion and risk response, and (5) extended market effects. For purposes of discussion, each of these aspects will be considered in the context of figures 3 and 4 where storage costs are ignored. However, the arguments have a straightforward generalization in the context of figure 5.

1/Darrell Hueth and Andrew Schmitz, "International Trade in Intermediate and Final Goods: Some Welfare Implications of Destabilized Prices," Quarterly Journal of Economics, Vol. 86 (1972), pp. 351-365.

SECTION 3

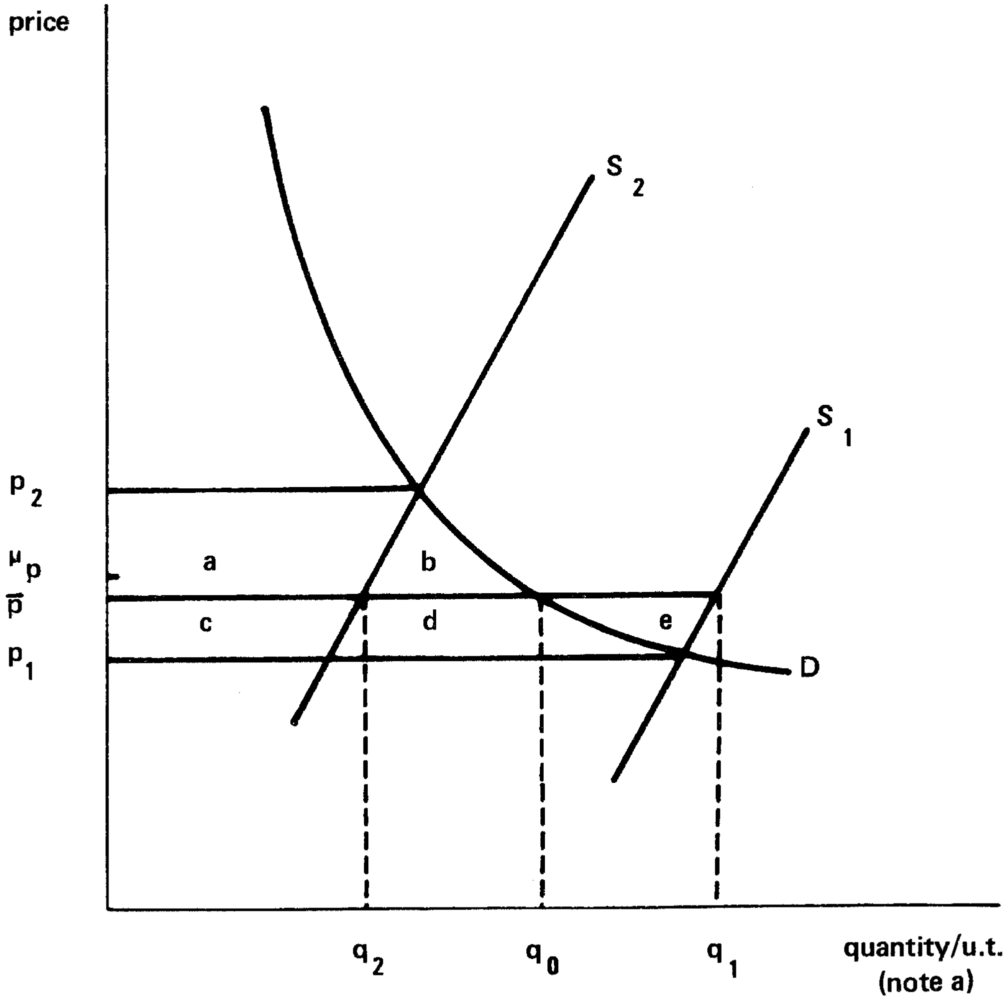
NONLINEARITY: IMPLICATIONS OF THE SHAPE OF SUPPLY AND DEMAND

The simple framework of section 2 is based on an assumption of linearity in supply and demand. To see the implications of nonlinearity, consider figure 6 where the demand curve D is nonlinear and supply alternates between S1 and S2. Now suppose price is stabilized by a buffer stock which purchases some production when supply is high and sells from buffer stocks when supply is low. For such a buffer stock to operate for a long period of time, the increase in stocks when supply is high must be the same as the decrease in stocks when supply is low. Otherwise, the buffer stock would either tend to accumulate until some of the stock would require disposal or stocks would tend to run out so that the stable price could not be enforced. With this requirement, excess supply, q1 - q0, at S1 is equal to excess demand, q0 - q2, at S2 so the buffer stock's sales in a short supply period are the same as its purchases in a long supply period; thus, its net welfare effect is zero on average with complete price stabilization (excluding storage and transactions costs). 1/

With this in mind, the stable price $\bar{p}$ in figure 6 must be chosen so that the horizontal distance between S1 and D is the same as between S2 and D. Hence, if demand is upward bending (convex) as in figure 6, then the stabilized price is lower than the average destabilized price; if demand is downward bending (concave), then stabilized price is above the average destabilized price. The welfare gains and losses for producers and consumers in terms of areas a, b, c, d, and e in figure 6 are exactly the same as in figure 3, except that areas a and b are now relatively large and areas c, d, and e are relatively small. As a result, an average net gain of 1/2 (area b + area e) is still possible, but now the average consumer effect of 1/2 [area (a + b) - area (c + d)] may be positive rather than negative (with sufficient nonlinearity) because the stabilized price is lower than the average destabilized price. Also, the average producer effect of 1/2 [area (c + d + e) - area a] can possibly become negative, thus obtaining exactly the opposite qualitative impacts on producers and consumers as suggested by figure 3.

1/It may also be noted that this requirement is satisfied by the analysis in figures 3 and 4 under linearity where shifts in supply or demand curves are parallel.

FIGURE 6



a/Quantity per unit of time.

A similar generalization of the analysis in figure 4 for the case of upward-bending (convex) supply also shows that sufficient nonlinearity in supply can reverse the qualitative effects of price stabilization when instability is due to fluctuations in demand.

These issues have been examined more generally in the theoretical literature by Turnovsky 1/ and Just, Lutz, Schmitz, and Turnovsky. 2/ Using special cases of assumptions similar to those used under linearity by Massell, 3/ Turnovsky has pioneered a methodology for examining the role of nonlinearity in determining the gains and distribution of gains from price stabilization. Further paralleling the work under linearity by Hueth and Schmitz, 4/ the Just *et al*. paper extends Turnovsky's methodology into a framework of international trade.

The framework of these papers is quite restrictive in that instability can only be assumed to arise from one sector at a time. Nevertheless, the results of the work carry considerable implications for empirical research. Contrary to the earlier work under linearity, Turnovsky concludes that, for a closed economy:

> "* * *the desirability of price stabilization for either producers or consumers does not depend upon the source of the price instability, but only upon the shapes of the deterministic components of the demand and supply curves." [5/]

Similar results developed by Just *et al*. with respect to importing and exporting countries also demonstrate that

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1/Stephen J. Turnovsky, "The Welfare Gains from Price Stabilization: A Nonlinear Analysis," Australian National University, 1974.

2/Richard E. Just, Ernst Lutz, Andrew Schmitz, and Stephen Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," *Journal of International Economics*, Vol. 8, No. 4 (Nov. 1978), pp. 551-563.

3/Massell, *op. cit*.

4/Hueth and Schmitz, *op. cit*.

5/Turnovsky, *op. cit*., p. 24.

shapes of supply and demand curves are critical in determining qualitative effects of stabilization.

Just *et al.* 1/ further demonstrate that an excessive degree of nonlinearity is not necessary to obtain a reversal in who gains and who loses over the case of linearity. Specifically, they show that, for the range of elasticity estimates forthcoming from most econometric studies of coarse grain supply and demand, a switch in specifications from linearity to log linearity can be sufficient for such a reversal depending on the source of instability. Just and Hallam have argued on this basis that any investigation of the effects of a policy which affects price stability should be undertaken only after econometric estimation of the degree of curvature in supply and demand. 2/

1/Richard E. Just, Ernst Lutz, Andrew Schmitz, and Stephen Turnovsky, "The Distribution of Welfare Gains From International Price Stabilization Under Distortions," *American Journal of Agricultural Economics*, Vol. 59 (1977), pp. 652-661.

2/Richard E. Just and J. Arne Hallam, "Functional Flexibility in Analysis of Commodity Price Stabilization Policy," *Proceedings, Journal of the American Statistical Association*, 1978, pp. 177-186.

SECTION 4

THE FORM OF DISTURBANCES: DIFFERENCES IN VARIATION OF QUANTITIES SUPPLIED AND DEMANDED AT HIGH PRICES VERSUS LOW PRICES

Another important issue in analyzing policies which affect price stability is the form of disturbance in the fluctuating supply or demand. In figures 3 through 6, the random fluctuations take place in a parallel or additive fashion. The form of the disturbances is additive in the sense that if supply or demand is written with quantity q as a function of price p, say f(p), then the actual demand or supply curves correspond to $q = f(p) + \varepsilon$ where ε is a random disturbance with the same variance regardless of price level, $E(\varepsilon) = 0$. One alternative form of disturbance defended, for example, by Turnovsky is the multiplicative specification $q = f(p)\varepsilon$, $E(\varepsilon) = 1$. 1/ Although these two alternative stochastic assumptions are admittedly simple, the theoretical literature has been able to argue on the basis of the results that "the [welfare] distributional conclusions are highly sensitive to the form of stochastic disturbance assumed." 2/ For example, one can compare the Just, Lutz, Schmitz, and Turnovsky 3/ results corresponding to linearity with those of Hueth and Schmitz. 4/ Using multiplicative disturbances, Just *et al*. show that, if domestic supply is sufficiently elastic compared with demand, then domestic consumers gain from stabilization of domestic supply disturbances (even with linearity) which is contrary to results obtained by Hueth and Schmitz with additive disturbances.

1/Stephen J. Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," *International Economic Review*, Vol. 17 (1976), pp. 133-148.

2/Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," *op. cit.*

3/Just, Lutz, Schmitz, and Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," *op. cit.*

4/Hueth and Schmitz, *op. cit.*

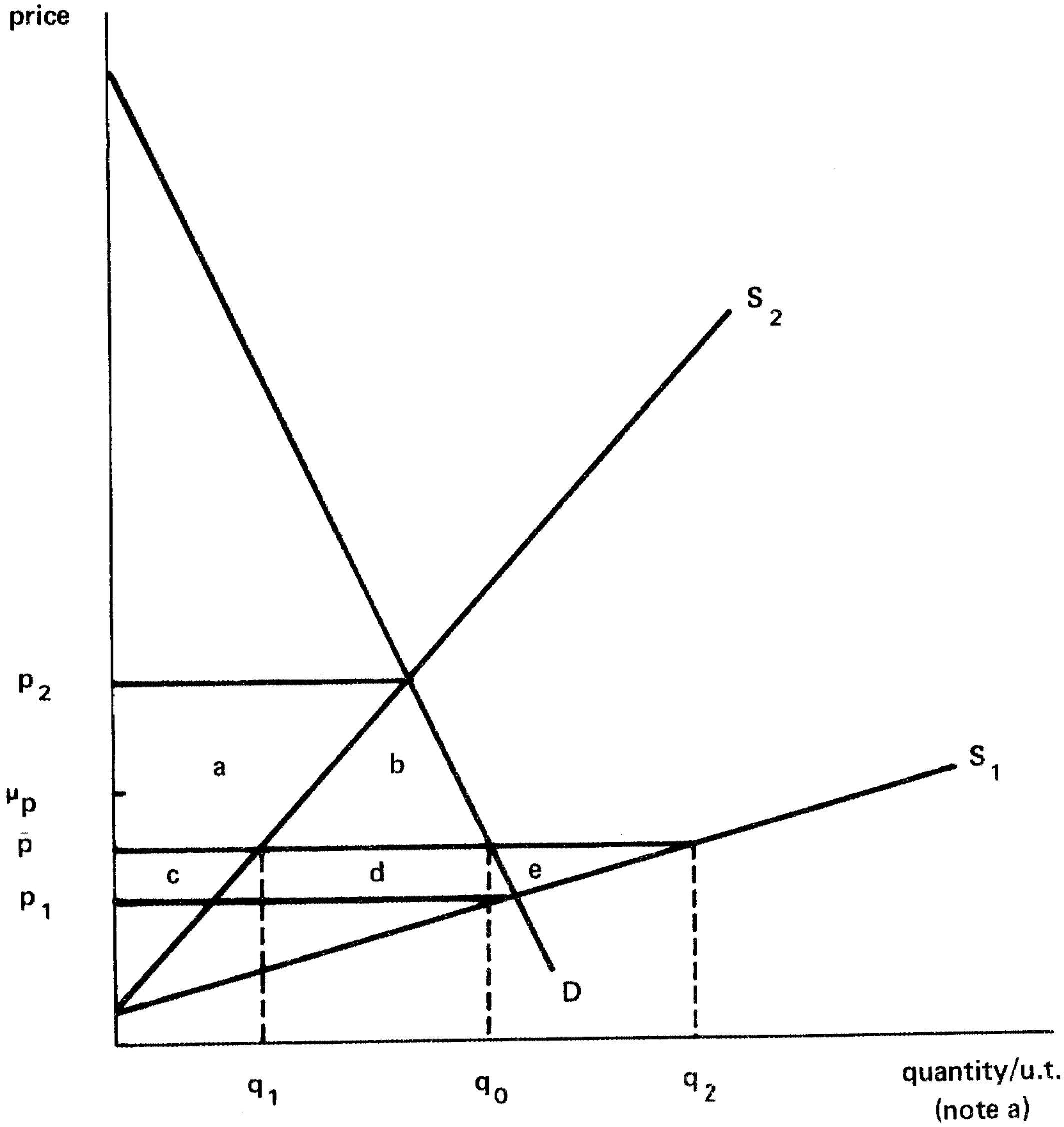
To demonstrate the comparative implications of these two specifications simply and graphically, suppose demand is stable at D as in figure 7 but that supply is unstable with multiplicative variation represented by fluctuations between S1 and S2 in alternating periods. By comparison, additive variation in supply is represented in figure 3. For buffer stocks to be self-liquidating, prices must be stabilized at p' where $q2 - q0 = q0 - q1$ rather than at the average destabilized price, $\mu p = (p1 + p2)/2$. Again, the welfare effects in figure 7 are the same as in figure 3 in terms of areas a, b, c, d, and e; but, again, as with nonlinearity, areas c, d, and e are smaller than areas a and b. As supplies S1 and S2 diverge (as the slope of S1 falls), these results are accentuated till area c + d + e = 0. Hence, with sufficiently strong multiplicative disturbances, net overall gains of 1/2 (area b + e) are still possible; but, again, even the qualitative implications for individuals or groups may switch. Producers may lose [if area (c + d + e) - area a < 0] and consumers may gain [if area (a + b) - area (c + d) > 0].

Results similar to those in figure 7 can also be developed for the case of multiplicative disturbances in demand in which case the qualitative implications can possibly be just opposite of those in figure 4 where demand disturbances are additive. 1/ Again, Just and Hallam have argued that the welfare effects of price stabilization policy cannot be adequately evaluated empirically without sufficient econometric estimation of the form of disturbances and, in fact, propose a procedure for doing so. 2/

1/The literature also implies that these conclusions carry over into models of general stochastic distributions. This is evident by comparing the results of Massell and of Hueth and Schmitz under additivity and linearity with those which pertain to the case of nonlinearity of Turnovsky and of Just, Lutz, Schmitz, and Turnovsky (where multiplicity is assumed). See Massell, op. cit.; Hueth and Schmitz, op. cit.; Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," op. cit; and R.E. Just, E. Lutz, A. Schmitz, and S. Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," op. cit.

2/Just and Hallam, op. cit.

FIGURE 7



a/Quantity per unit of time.

SECTION 5

RESPONSE OF PRIVATE STORAGE TO PUBLIC INTERVENTION: TO WHAT EXTENT ARE PRIVATE STOCKS REDUCED WHEN GOVERNMENT-CONTROLLED STOCKS ACCUMULATE?

Another issue which must be considered with any potential Government policy is that economic stability may not be affected only directly but also indirectly because of private decisionmakers' reactions to the direct effects of the policy. For example, when a large Government buffer stock is established to stabilize prices, the demand for private inventories will likely change because future supplies are more certain. That is, if some private stocks--in addition to working stocks--are held for speculation (the hope that future price will be higher than present price plus storage costs), then the purpose of holding speculative stocks would be negated by a Government policy of price stabilization at some announced price. But this system leads to a greater reliance of private concerns on public stocks. In fact, this consideration raises the question of whether or not private stocks may be held in optimal amounts in the absence of a reserve policy so that no public stocks are needed.

Consider, for example, the diagrammatic analysis of figure 3. If storage costs are negligible and producers gain from price stabilization, then the same gains can be assured if producers undertake stock operations on their own. They simply need to carry stocks of q1 - q0 from high supply years over to periods of low supply. Alternatively, other private decisionmakers would be induced to enter the private storage industry if they were assured of receiving a sales price higher than their purchase price, as in figure 3.

On the other hand, if storage costs are considerable, private storage would not be induced to such a great extent. For example, consider figure 5 where storage costs are p2' - p1' per unit. Then, if price with S1 is less than p1' and price with S2 is greater than p2', profits could be made by private firms by purchasing at the low price, storing, and selling at the high price. Private storage would increase until price at S1 is p1' and price at S2 is p2' where the stock purchased with S1 is q4 - q3 and is equal to the amount sold from stocks, q2 - q1, with short supply S2. In this case, the welfare areas a, b, c, d, and e measure the benefits just as in the case where the Government holds stocks in section 2. The sales from stocks are at a price just high enough to exactly cover purchase and storage costs, and if less stocks are held, there is a profit incentive to hold more private stocks.

Now suppose in this framework that a public storage program is undertaken to further stabilize prices. If the Government attempts to increase total stock purchases to q4' - $\bar{q}$ when S1 occurs by purchasing public stocks of (q4' - $\bar{q}$) - (q4 - q3) and selling an equal amount in periods of low supply, then private storers of the commodity can no longer cover their storage costs and will reduce private inventories until prices again vary between p1' and p2' or until private storage ceases. It should be further noted, however, that any public storage beyond q4 - q3 would lead to reduced overall benefits for consumers, producers, and Government jointly because the increase in storage cost would be greater than net consumer plus producer gains.

The framework used in this section to demonstrate the reaction of private concerns to price-stabilizing effects of public reserve policy is admittedly quite simple and serves only as an illustration. A number of other issues must also be considered, such as differences in private and public storage costs, time preference discounting, the length of time in storage, credit availability, risk preferences, etc. With these considerations, private stocks may not be optimal. 1/ For example, because of lack of credit, private storage may not be able to respond to expectations of future shortage. Or because of high risk aversion, a farmer may be less inclined to store grain rather than sell at a certain current price.

1/Richard E. Just and Andrew Schmitz, "The Instability-Storage-Cost-Trade-Off and Nonoptimality of Price Bands in Stabilization Policy," Giannini Foundation Working Paper, Department of Agricultural and Resource Economics, University of California, Berkeley, 1979.

SECTION 6

RISK PREFERENCES AND DISCOUNTING OF PROFITS ASSOCIATED WITH INSTABILITY

Thus far, any preferences for stable or unstable prices have been discussed solely in terms of gain in expected economic surpluses, which essentially reflect expected economic profits. For individuals who neither like nor dislike random outcomes--that is, for risk-neutral individuals--these results are appropriate. A risk-neutral individual is one who is indifferent to randomness in, say, income as long as expected income is unaltered. Some individuals, however, may have a great aversion to risk. For example, a producer may prefer earning profits of $20,000 year after year to earning profits of $10,000 or $40,000 each with probability 0.5. This preference may be due to economic reasons, such as more efficient planning possibilities, as well as to purely psychological factors, such as emotional trauma. To reflect these kinds of preferences, the economic surplus concepts used above must be further modified.

Of course, as price stability is attained, risk can be greatly reduced. And as risk is reduced, risk-responsive producers may increase supply; as a result, both producer and consumer welfare may increase by more than the standard Massell-Turnovsky risk-neutrality assumptions would indicate. Furthermore, any public buffer stock could accumulate indefinitely at stabilized prices that would otherwise be reasonable. 1/ Again, the theoretical results are disturbing and imply that estimates of gains from stabilization may be seriously biased and any efforts to determine an optimal stabilization policy--for example a normal price about which to stabilize--may be in vain when risk preferences and responses are not considered. Of course, the possibility of forward contracting may render risk an unimportant factor in decisionmaking in which case these considerations may be unnecessary; however, transactions costs of using forward contracting markets may be prohibitive especially for small farmers. Thus, the importance of risk is an empirical question which must be answered by the data.

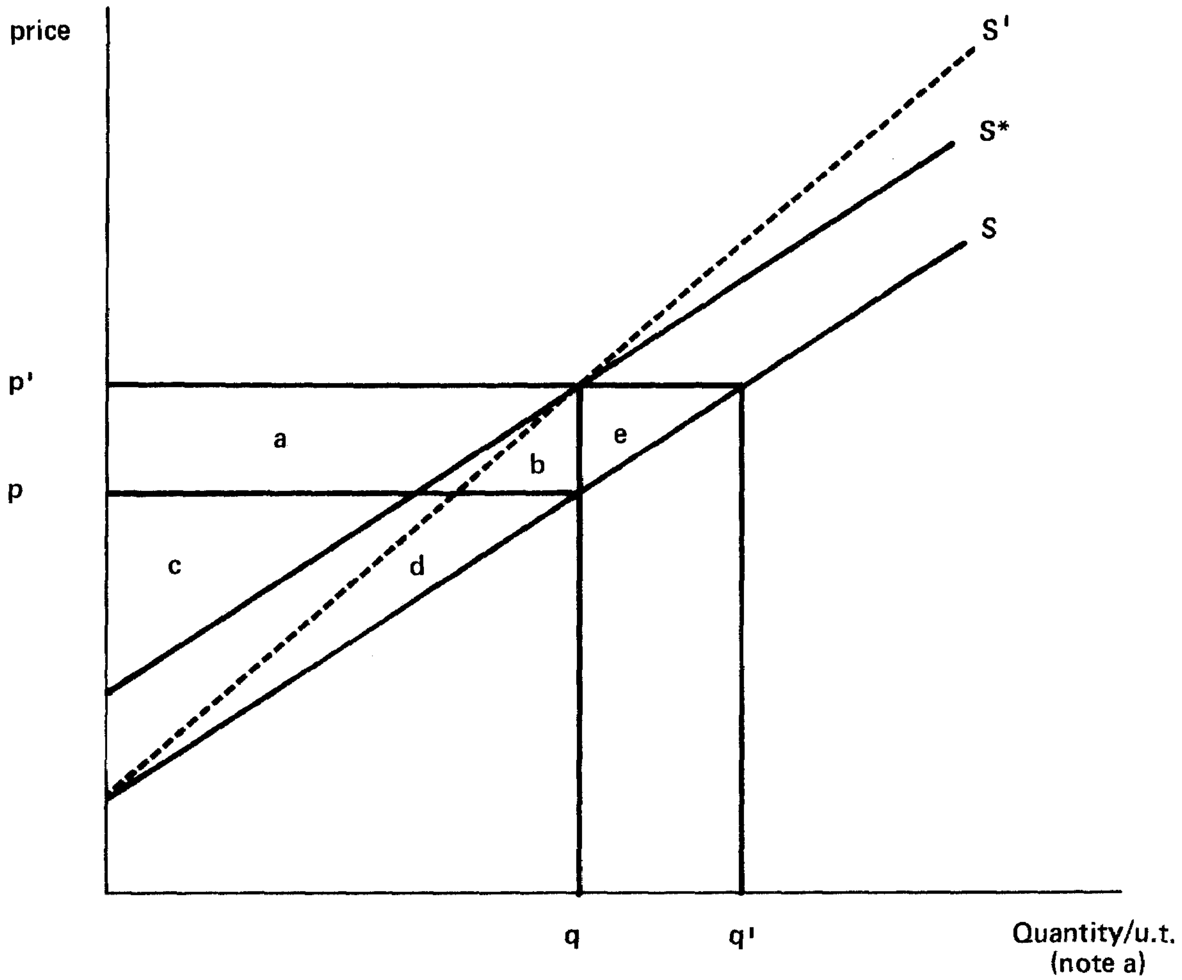
1/This complication is discussed by Richard E. Just, "Risk Response Models and Their Use in Agricultural Policy Evaluation," American Journal of Agricultural Economics, Vol. 57 (1975), pp. 836-843.

The topic of welfare measurement for producers operating with risk has been addressed in the context of stabilization policy by Just and Hallam. 1/ They find that again changes in welfare are adequately reflected by changes in the area above the supply curve and below price if a producer's economic welfare depends linearly on expected profits and the variance of profits. With risk, however, the relevant supply curve depends on expected price (possibly a function of lagged prices) and the subjective variance of price (also possibly determined by previous experience). 2/ Specifically, consider the risk-neutral supply curve or certainty supply curve S in figure 8. Now suppose that the introduction of a given amount of price risk causes the producer to contract production so that supply shifts to S*. The results by Just and Hallam show that the appropriate curve to use in measuring economic welfare effects for the producer is the curve S* which holds the amount of risk constant. Thus, the surplus area which reflects economic welfare under risk is is area a + c at expected price p'. Under risk neutrality or certainty at p', the supply curve S would imply real income of area a + b + c + d + e so the real income loss associated with price uncertainty is area b + d + e. Of course, if the risk response from q to q' associated with price stabilization is ignored, then the associated real income benefits of area b + d + e would be ignored. Thus, the identification of significant risk preferences as evidenced by risk-responsive decisions may be crucial in justifying a price-stabilization policy.

1/R.E. Just and J.A. Hallam, "New Developments in Econometric Evaluation of Price Stabilizing and Destabilizing Policies," in New Directions in Econometric Modelling and Forecasting in U.S. Agriculture, ed. Gordon C. Rausser (Amsterdam: North-Holland), 1981.

2/Or, alternatively in the case of grain supply, acreage can be specified as depending on the subjective mean and variance of returns per acre. Such a specification automatically corrects for any correlation between prices and yields which may otherwise have differing implications for income stability when price is stabilized. That is, due to negative correlation between price and average yield, price stability may actually destabilize income; if so, this would be appropriately reflected by returns per acre.

FIGURE 8



a/Quantity per unit of time.

SECTION 7

EXTENDED MARKET EFFECTS OF STABILIZATION

Another issue which has been considered to a limited extent in the theoretical literature is effects of stabilization on related markets. For example, if the grain market price is stabilized, there may be some implications for the cattle market which impact on consumer meat price stability. Assurance of stable feed grain prices may cause increased beef production or greater cattle market price stability. These considerations thus relate to relaxing the partiality of welfare measurements--an aspect of economic welfare measurement which has received heavy criticism over the years.

Just and Salkin show that these considerations depend crucially on the stochastic nature of production at various market levels. 1/ Their results show that intermediate industries gain from price stabilization of any related market if their production processes are stochastic but they are unaffected if their production processes are nonstochastic. Thus, for example, if corn price is stabilized, corn producers should gain since their production is stochastic; feed processing industries should be unaffected if their production process is nonstochastic; and cattle feeders would gain to the extent that feed gains and death losses are stochastic.

Perhaps a more serious result obtained in their work, however, relates to whether input supplies (say, of fertilizer, seed, fuel, etc.) and final consumption demand for meat and grain products are stochastic. If these components are nonstochastic, then the gains for intermediate producing industries (grain and livestock farmers) come only at the expense of input suppliers and final consumers. In the case of grain markets, it seems reasonable that some input supplies are stable while others are less stable. On the demand side, domestic meat and grain demand would seem to be fairly stable although export demand may be less stable. Thus, some overall gains seem to be possible but the extent of gains from stabilized grain prices may be considerably less than economic analysis of the grain market alone would indicate.

1/R.E. Just and M.S. Salkin, "Welfare Effects of Stabilization in a Vertical Market Chain," Southern Economic Journal, Vol. 42 (1976), pp. 633-643.

In view of these results, unstable prices do not necessarily imply that possibilities exist for improving economic welfare through price stabilization, even in net terms or after compensation. Although these results were derived in a linearized model, they clearly imply that consideration of the extended market situation is necessary in evaluating the effects of any price-stabilization policy.

SECTION 8

THE IMPLICATIONS OF THEORETICAL WORK FOR EVALUATION OF RESERVE POLICY UNDER THE FOOD AND AGRICULTURE ACT OF 1977

The reserve policy instituted with the Food and Agriculture Act of 1977 represented an important departure from previous agricultural policy. Before 1977 U.S. grain policy relied mainly on price supports sometimes augmented by marketing quotas for the purpose of protecting farm incomes from down side risk. When huge grain stocks began to accumulate, however, officials quickly realized that any rule for accumulating stocks (e.g., a loan rate program) must be accompanied by an orderly rule for liquidating those stocks. When stock liquidation was undertaken as prices exceeded loan rates, the huge grain stocks caused the loan rate to act somewhat like a price ceiling as well as a price floor. In this context, the spread between loan rate and release levels in the current policy provides a margin which makes Government storage or Government-financed storage seem more worthwhile according to the comparative analysis of figures 3 and 5.

More importantly, in light of the extreme price instability of the early 1970s and the observed price-depressing effect of stock liquidation a decade or so earlier, the current reserve policy represents an effort to bound price variation both above and below. Under the current reserve policy, excess supply from bumper crops can be placed in storage to prevent excessively low prices; then in years of shortage these stocks can be liquidated to mitigate excessively large price increases which would otherwise destabilize the industry.

The imposition of a price support alone (at least initially) tends to truncate the lower side of the price distribution and thus raises expected price. The current reserve policy, on the other hand, tends to truncate both sides of the price distribution and thus may neither raise nor lower the long-run expected price while reducing the variance of price. Thus, by definition, the effects of most earlier policies were of first order. That is, imposed changes involved shifts in mean prices, the effects of which could be investigated using first order approximations of supply and demand curves.

The current policy, however, may involve only second order impacts. That is, mean prices may be unaffected while the variance of price may be reduced substantially. As shown by the various theoretical studies surveyed above, an evaluation of the distributional economic impacts of a reserve policy which shrinks the price distribution by means of a self-liquidating buffer stock rule is necessarily sensitive to second order considerations, such as curvature of supply and demand, the form of disturbances, risk response, etc.

The results surveyed above show that almost nothing can be determined on the basis of economic theory alone about which groups gain and which lose from price stabilization with such a reserve policy. If demand and supply are linear, producers may gain and consumers lose, while if demand and supply are nonlinear (with the same price elasticities at current price levels), consumers may gain while producers lose. The same difference may apply if disturbances in supply and demand are multiplicative rather than additive. In other words, theory cannot determine whether producers benefit from a reserve policy that stabilizes prices. Nor can theory alone determine whether consumers benefit from a reserve policy. The only obvious distributional conclusion is that taxpayers lose because the Government pays storage costs without receiving the benefits of selling accumulated stocks at higher prices than at which they were purchased or accumulated. Similarly, the aggregate effects are also unclear. For example, with sufficient response of private storage to public storage decisions, a program can be completely ineffective in the aggregate. Since theory cannot determine even the qualitative impacts of reserve policy on producers and consumers, any specific analysis of the current release and call levels in absence of specific empirical information is, of course, futile.

The theoretical results outlined above, however, indicate some important generalities which must be considered in an empirical analysis of the current reserve policy. Consider, for example, the implications of the results relating to <u>nonlinearity</u> in section 3 for empirical and simulation studies of stabilization. The theory implies that any empirical study which does not adequately investigate at least second order functional form may, in fact, be determining results through arbitrary specifications and assumptions. First order approximation in the range of relevancy is not sufficient as in most econometric problems (e.g., price forecasting), since standard welfare measures depend on the shape as well as the position of supply and demand curves.

Unfortunately these considerations have generally not been made in empirical stabilization studies. Nonlinearity, of course, is a problem that has often plagued econometricians. The usual empirical or simulation approach, which has been continued in stabilization studies, has been simply to specify a linear or log linear form. Hence, simplistic as the theoretical studies may be, they invalidate the use of such empirical work on distributional aspects of economic welfare analysis. These conclusions are supported by the empirical work of Reutlinger who, in using crude, piecewise linear demand curves, concluded that "the storage impact on gains and losses by consumers and producers is particularly sensitive to the assumed shape of the demand function." 1/

Similarly, with respect to the form of disturbances, one must conclude that an empirical study which specifies the form of disturbance *a priori* may be influencing not only the quantitative but also the qualitative nature of the distributional results obtained. As Turnovsky concludes, "unless the policy maker has reliable information on this question, any stabilization policy may have undesirable effects on the group it is intended to assist." 2/

To what extent have these considerations been made in empirical studies of stabilization? Unfortunately, very little if at all. Most studies assume either additive or multiplicative disturbances depending on whether or not linearity or log linearity is assumed. Again, as with nonlinearity, it must be concluded that little confidence can be placed in empirical and simulation studies until the form of random disturbances is adequately investigated.

Similarly, examination of the empirical stabilization literature reveals that risk response has been considered only rarely even though consideration in applied econometrics is becoming common. The traditional stabilization studies which have used econometric estimates of supply and demand have almost universally ignored risk response. Hazell and Scandizzo, however, have been able to treat risk response by

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1/Shlomo Reutlinger, "A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat," *American Journal of Agricultural Economics*, Vol. 58 (1976), pp. 1-12.

2/Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," *op. cit.*, p. 145.

using a mean-variance programing approach to agricultural supply. 1/ Although their programing model is more restrictive in behavioral assumptions than econometric studies of stabilization, their results are consistent with those of the theoretical implications cited above and raise further doubts about empirical work which ignores risk response. In fact, they conclude that "the potential welfare gains to be had from optimal intervention policies are surprisingly large, in fact far greater than might be anticipated" in the case where risk response is considered. 2/

Likewise, another area in which empirical work has apparently been weak relates to the role of private storage. For example, the empirical work of Cochrane and Danin, 3/ Reutlinger, 4/ and Sharples *et al*. 5/ has been heavily criticized by Helmberger and Weaver 6/ because it ignores the stabilizing effect of private storage as well as the reaction of private storage supply to the imposition of a public storage program. As Helmberger and Weaver show, the distribution of welfare gains from price stabilization may be much different when these reactions are adequately considered. As shown above, if the Government institutes a storage program, then private concerns can tend to carry fewer stocks because there is less chance of shortage.

1/P.B.R. Hazell and P.L. Scandizzo, "Optimal Price Intervention Policies When Production is Risky," presented at the Agricultural Development Council Conference on Risk and Uncertainty in Agricultural Development, CIMMYT, Mexico, 1976.

2/Hazell and Scandizzo, *op. cit*., p. 18.

3/Willard W. Cochrane and Yigal Danin, *Reserve Stock Grain Models, the World and United States, 1975-1985*, Minnesota Agricultural Experiment Station Technical Bulletin No. 305, 1976.

4/Reutlinger, *op. cit*.

5/J.A. Sharples, R.L. Walker, and R.W. Slaughter, Jr., "Buffer Stock Management for Wheat Price Stabilization," Commodity Economics Division, Economic Research Service, United States Department of Agriculture, Washington, D.C., 1976.

6/Peter Helmberger and Rob Weaver, "Welfare Implications of Commodity Storage Under Uncertainty," *American Journal of Agricultural Economics*, Vol. 59 (1977), pp. 639-651.

Hence, some welfare effects from price stabilization are felt by private holders of stocks in addition to those experienced by producers and consumers. Furthermore, if private storage increases when Government storage is decreased, then prices are probably not destabilized as much as if private storage did not respond. Given the empirical research which verifies private storage supply response, 1/ one must view most empirical work on stabilization policy with yet a further degree of skepticism.

Finally, in the case of considering extended market effects of stabilization, it appears that empirical work is almost nonexistent. Empirical studies of stabilization policy have almost universally been considered only for the specific market in which controls are introduced.

In view of these considerations, it appears that the vast majority of empirical work is not general enough to be reliable for reserve policy analysis. One study conducted thus far which considers much of the empirical generality suggested by the above arguments is that of Just and Hallam, but it relates only to the wheat market and is developed only for illustrative purposes. 2/ However, they conclude that while the wide range of theoretical implications suggests that almost nothing can be determined *a priori* (even in qualitative terms), a fairly high degree of confidence may be empirically possible when the same set of flexibilities is considered. In point of fact their results suggest that many of the theoretical ambiguities discussed above can be resolved empirically with a reasonable level of confidence. In other words, meaningful empirical work may be possible but only after examining a considerable level of generality in demands, supplies, and extended market relationships.

1/See, for example, Ernst Lutz, "Grain Reserves and International Price Stabilization," unpublished Ph.D. thesis, Department of Agricultural and Resource Economics, University of California, Berkeley, 1977.

2/Just and Hallam, *op. cit.*

SECTION 9

SPECIFICATION OF A MODEL FOR ECONOMIC ANALYSIS OF RESERVE POLICY

The discussion thus far suggests several important features which should be considered in developing any empirical model for investigating price stabilization policy. First, flexibility with regard to nonlinearity seems crucial. Several possibilities allow simple econometric tractability. One could simply consider a second order, Taylor-series approximation of appropriate functions--i.e., use quadratic equations in price rather than follow the usual first order econometric approach of linearity. Another possibility is suggested by the translog function which has become popular in production studies and is now finding use in demand analysis--i.e., use of double-log functions which are quadratic in the logarithm of price (rather than linear in logs as in the Cobb-Douglas case). Other possibilities, such as generalized Leontief functional forms provide flexibility with respect to nonlinearity.

For the purposes of this study, none of these possibilities provide a suitable alternative. That is, the popular demand functions which allow flexible curvature admit U shapes convex to the origin, in which case curves may not cross the price axis (if quantity is the dependent variable) or the quantity axis (if price is the dependent variable). In the former case, the economic surplus concept which measures real income for consumers does not exist, and even <u>changes</u> in this measure of real income are not well defined if demand determinants change. In the latter case some policies may lead to use of the upward sloping part of the estimated demand curve and, in fact, estimates can often suggest upward sloping demand even within the limits of observed data.

An alternative specification suggested for this type of work by Just and Hallam is

$$q_t = a_0 + a_1 (P_2)^{\alpha} + a_2 Z_t + \varepsilon_t \qquad (1)$$

where q_t is quantity demanded, P_t is price, Z_t represents relevant determinants of demand, and ε_t is a random disturbance, $E(\varepsilon_t) = 0$. 1/ With this specification, complete freedom in fitting first and second derivatives is maintained for arbitrary price-quantity combinations. That is, values of a_1 and α can be chosen to satisfy any arbitrary values of the first and second derivatives for any given price P_t or quantity q_t. Furthermore, the demand function in (1) not only provides at least a second order local approximation of any demand curve but also does so without admitting a troublesome U shape. In fact, if the law of demand is satisfied anywhere, then it will be satisfied all along the demand curve (in which case $a_1 \ \alpha < 0$). If the demand curve is also concave to the origin (downward bending), then it clearly intersects both the price and quantity axes. If the demand curve is convex, on the other hand, then it may become vertical at some positive quantity and thus not cross the price axis. Even this problem is simply avoidable by imposing the constraint $a_0 + a_2 Z_t + \varepsilon_t < 0$ in estimation of a_0 and a_2 so that a well-defined consumer welfare measure always exists under the usual properties of demand. But, of course, some of the flexibility discussed above is lost in so doing.

Turning to the form of disturbance, the functional form in (1) carries additional empirical convenience. That is, even if a multiplicative disturbance δ_t is appropriate, $q_t = (a_0 + a_1 (P_t)^\alpha + a_2 Z_t) \delta_t$, $E(\delta_t) = 1$, $V(\delta_t) = \sigma_\delta$, the representation in equation (1) can be used by simply defining $\varepsilon_t = [a_0 + a_1 (P_t)^\alpha + a_2 Z_t] \chi (\delta_t - 1)$. Even with heteroscedastic disturbances, ordinary estimation procedures lead to consistent estimators under reasonable circumstances (uniformly bounded variances, etc.). Hence, the investigation of the form of disturbances need not confound estimation of supply and demand but may be investigated subsequently on the basis of estimated disturbances as suggested by the estimation procedures proposed in other contexts by Hildreth and Houck 1/ or, in a more closely related paper, by Just and Pope. 2/ The possibility that the

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1/Clifford Hildreth and James P. Houck, "Some Estimators for a Linear Model with Random Coefficients," Journal of the American Statistical Association, Vol. 63 (1968), pp. 584-595.

2/Richard E. Just and Rulon D. Pope, "Stochastic Specification of Production Functions and Economic Implications," Journal of Econometrics, Vol. 7 (1978), pp. 67-86.

variances of ε_t at different prices along the curves are proportional to the square of expected quantities at those respective prices can be investigated separately using a regression equation of the form,

$$\hat{\varepsilon}_t^2 = \gamma_0 + \gamma_1 \hat{q}_t^2 + e_t, \qquad E(e_t) = 0, \qquad (2)$$

where $\hat{q}_t$ is the estimated nonstochastic component of (1) and $\gamma_0 = 0$, $\gamma_1 \neq 0$ suggests multiplicative disturbances and $\gamma_0 \neq 0$, $\gamma_1 = 0$ suggests additive (homoscedastic) disturbances or, for the purposes of this study, both extremes can be investigated empirically. 1/

To consider the possibility of risk response in supply econometrically, a modification of the adaptive risk-response model proposed and used by Just provides an intuitive possibility. 2/ In this model, which presupposes lags in supply response, the quantity supplied q_t depends on the subjective mean of prices μ_t and the subjective variance of the same, σ_t^*, as well as other determinants X_t, e.g.,

$$q_t = b_0 + b_1\mu_t + b_2\sigma_t^* + b_3X_t + V_t, \qquad E(V_t) = 0. \qquad (3)$$

Where $q_t = b_0 + b_1\mu_t + b_3X_t + V_t$ is a risk-neutral supply curve, the linear term $b_2 \sigma_2^*$ is added to represent the shift from S to S* in figure 8. Such a supply response model is neatly

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1/Note that a further modification of this approach is required when P and q are determined simultaneously. One alternative is to use instrumental variables methods in which the instruments are developed by regressing q on the determinants underlying supply and demand. See Just and Hallam, op. cit., for further details.

2/Richard E. Just, Econometric Analysis of Production Decisions with Government Intervention: The Case of the California Field Crops, Giannini Foundation Monograph No. 33, University of California, Berkeley, 1974, and "Estimation of an Adaptive Expectations Model," International Economic Review, Vol. 18 (1977), pp. 629-644.

applicable in measuring the welfare effects of changing risk, as discussed above, since it conditions the supply curve on a given level of the variance associated with a given subjective returns situation. One possibility is to specify subjective parameters following an adaptive expectations model,

$$\mu_t = \sum_{k=0}^{\infty} \theta^k \, r_{t-k-1} \quad (4)$$

$$\sigma_t^{*2} = \sum_{k=0}^{\infty} \theta^k \, (r_{t-k-1} - \mu_{t-k-1})^2, \quad (5)$$

where r_t represents returns per acre in time period t.

The additional consideration suggested by the earlier discussion relates to the impact of public stocks on private inventories. As suggested by other recent work, 1/ this possibility can be considered simply by including Government stocks or farmer-owned reserves under Government programs as an additional determinant of private inventory demand.

Consider now the specification of a model of the U.S. agricultural economy for investigation of U.S. grain reserve policy. As suggested by earlier studies such as Cromarty 2/ and Mo, 3/ more precise estimation of demand is possible by breaking total private grain demand into components such as food, feed, inventory, and export. With this in mind, grain demands are broken into consumption, stock, and export demands for purposes of estimation. Consumption is assumed to be influenced by consumer income, grain consuming livestock numbers, and seasonal factors in addition to grain

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1/See, e.g., Helmberger and Weaver, *op. cit.*, and Lutz, *op. cit.*

2/William A. Cromarty, "An Econometric Model for United States Agriculture," *Journal of the American Statistical Association*, Vol. 54 (1954), pp. 556-574.

3/M.Y. Mo, "An Econometric Analysis of the Dynamics of the U.S. Wheat Sector," USDA Technical Bulletin No. 1395, Washington, D.C., 1968.

price. 1/ Market demand for grain stocks is assumed to depend on price, production, carryin market stocks, carryin Government stocks, and seasonal factors. Export demand depends on price, the terms of trade or exchange rate between the United States and other countries, carryin of stocks outside the United States, and seasonal factors. On the other side of the market, production depends on subjective assessments of market price possibilities (both mean and risk) and diversion or set-aside requirements under Government programs. 2/ Subjective assessments for market price are assumed to follow an adaptive expectations mechanism such as in (4) and (5).

Since a major purpose of this study is to determine the effect of the farmer-owned reserve program on the livestock sector, a model of the livestock sector and the grain-livestock linkage is needed. For this purpose, demands for beef, pork, and poultry are assumed to depend on prices of the alternative meats (e.g., beef demand depends on pork and poultry prices), consumer income, and seasonal factors. Beef and pork supply depends on cattle placed on feed or hogs kept for market with appropriate lags and seasonal

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1/Although one might suspect that livestock producers may change the quantity of feed per animal and thus change feed demand more than reflected by livestock numbers on feed when livestock prices change, this is apparently not the case to any significant degree since implausible results were obtained when both livestock prices and grain consuming livestock numbers were included in estimating grain consumption. This has apparently been the case in other studies as well since the structure used here is similar to that resulting in other econometric studies of the livestock sector.

2/While this supply specification may appear somewhat simplistic compared with annual studies which use 2 or 3 decades of data, one must bear in mind that supply is estimated here in a quarterly model using only 13 years of data from a policy period which is much more comparable with current supply. As evidenced by the estimates below, this simple specification fits the 13 years quite well.

factors. 1/ Beef cattle placed on feed depends on cattle prices, feed prices, beef cow inventories with an appropriate lag, and seasonal factors. Similarly, hogs kept for market depends on hog prices, feed prices, breeding hog inventories with an appropriate lag, and seasonal factors. Likewise, beef cow inventories respond to cattle prices and other seasonal factors and breeding hog inventories respond to hog prices, feed prices, and other seasonal factors. Poultry supply depends on poultry prices, feed prices, and seasonal factors.

The general structure of the livestock sector follows along lines used previously by Arzac and Wilkinson, 2/ Crom, 3/ Fox, 4/ Freebairn and Rausser, 5/ and others. However, livestock demand coefficients are constrained to satisfy symmetry conditions so that cross welfare effects (e.g., the effects of grain policy on livestock producers) are theoretically sensible.

In all cases except the grain production equations, estimates were developed by truncated two-stage least

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1/Although it may seem desirable to include price as well as livestock numbers on feed in estimating short-run beef and pork supply, the traditional problem of a negative price effect was encountered. This result reflects the fact that livestock producers tend to hold back more stock for breeding when prices are rising. However, this effect is extremely small and greatly complicates the welfare analysis below. Thus, the current quarterly price is not included in estimating beef and pork supply (for the same reasons it has not been included in many other econometric studies of the livestock industry).

2/E.R. Arzac and M. Wilkinson, "A Quarterly Econometric Model of United States Livestock and Feed Grain Markets and Some of the Policy Implications," American Journal of Agricultural Economics, Vol. 61 (1979), pp. 297-308.

3/R.J. Crom, "A Dynamic Price-Output Model of the Beef and Pork Sectors," USDA ERS Technical Bulletin No. 1426, 1970.

4/K.A. Fox, "A Submodel of the Agricultural Sector," The Brookings Quarterly Econometric Model of the United States ed. J.S. Duesenberry, G. Fromm, L.R. Klein, and E. Kuh (Amsterdam: North-Holland Publishing Co.), 1965.

5/J.W. Freebairn and G.C. Rausser, "Effects of Changes in the Level of U.S. Beef Imports," American Journal of Agricultural Economics, Vol. 57 (1975), pp. 676-688.

squares, except for the nonlinear parameters which were estimated by search techniques. To make the model fully quarterly in specification (which is important for the economic welfare analysis), a few variables--namely, livestock inventories--had to be interpolated from annual or semiannual data and grain production had to be attributed to a specific quarter of the year. Also, since appropriate software was not available in the context of this project, the equations could not be estimated directly by nonlinear means. As a result and because of the number of nonlinear parameters, the nonlinear parameters were only computed to an accuracy of 0.125 and therefore standard errors of estimates can only be reported subject to these nonlinear parameter estimates. 1/

The estimated model, along with variable definitions and sample periods for each equation, appears in table 1. Functional forms for demand follow equation (1) in every case, while grain supply follows the functional specification in equation (3). Nonlinearity was not investigated in supply of either grains or livestock because supplies are essentially inelastic and determined by lagged phenomena. (Nonlinearity of supply with respect to current price becomes a trivial issue when supply is perfectly inelastic.) In the context of the earlier discussion, however, the responsiveness to risk in supply is of crucial interest.

Responsiveness to risk was investigated for producers of wheat, corn, cattle, and hogs. 2/ For livestock producers, risk was considered for both livestock prices and feed (corn) prices. Results generally did not show a significant response to risk. Only in the case of hog producers did risk appear to play an important role; the significant response is in the stock of pigs held for breeding. Several alternative explanations may be given for the lack of significant empirical risk response. First, risk may simply not have changed very much over the sample period so that there is no differential response to

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1/In addition, the nonlinear parameters were selected subject to constraints of economic surplus existence (i.e., that the demand curves cross the price axis for sufficiently large prices). These constraints were effective for grain disappearance and beef demand.

2/Due to limited space, these results and a number of others that are not central to the specific results below will be discussed without presentation.

pick up. Second, risk may be important only over longer planning horizons than are of interest in the quarterly model developed here. Indeed, for hogs the significant response occurs only in the equation related to the longest planning horizon. Third, the expectation and risk terms may be so collinear that identification of differential effects is not possible. Finally, decisionmakers may actually be risk-neutral. Examination of the data suggests that risk has changed fairly substantially from the 1960s to the 1970s even over short planning horizons. However, the expectation and risk terms are highly correlated; both price levels and risk increased simultaneously with the commodity boom of the early 1970s. To the extent that this correlation continues, the model estimated in table 1 would be valid for investigating stabilization policy regardless of the importance of risk in reality. This would generally not be the case for all types of stabilization policy but appears to be a reasonable assumption for the particular investigations presented below. 1/

1/It may be further noted that, in those cases where risk coefficients did not turn out to be important, the welfare calculations reduce to the same as those discussed in earlier sections for the non-risk-responsive cases. This occurs on the supply side because lags make supplies inelastic with respect to current price.

TABLE 1

ESTIMATED GRAIN-LIVESTOCK MODEL (note a)

Wheat Market Behavioral Equations

$$QDWHT = \underset{(136.9)}{185.8} - \underset{(.1069)}{0.1568}\ QDWHT_{t-1} - \underset{(235.1)}{546.6}\ (PWHT/WPI)^{.375}$$

$$+ \underset{(0.03461)}{0.09584}\ DI_{72} + \underset{(2.899)}{1.642}\ GCAU - \underset{(11.15)}{70.84}\ Q2 + \underset{(13.54)}{68.71}\ Q3 + \underset{(14.445)}{4.494}\ Q4$$

$R^2 = .73$ $\bar{R}^2 = .71$ DW = 2.10 $\sigma = 36.16$ PRMSE = 20.5 1957 IV/1979 III

$$STWHT = \underset{(130.9)}{161.8} + \underset{(0.0629)}{0.7708}\ STWHT_{t-1}\ \underset{(.4527)}{2.2610}\ (PWHT/WPI)^{1.125} + \underset{(.0850)}{0.8317}\ PWPR$$

$$- \underset{(.08996)}{.04358}\ GOVWHT - \underset{(.1953)}{0.8095}\ FORWHT + \underset{(40.30)}{50.44}\ Q2 - \underset{(150.1)}{116.5}\ Q3 + \underset{(40.87)}{82.77}\ Q4$$

$R^2 = .99$ $\bar{R}^2 = .98$ DW = 2.00 $\sigma = 63.14$ PRMSE = 5.0 1969 I/1978 II

$$EXWHT = \underset{(206.7)}{521.8} + \underset{(.1948)}{.3369}\ EXWHT_{t-1}\ \underset{(2.776 \times 10^{15})}{2.782 \times 10^{15}}\ (PWHT/WPI)^{9.125} \underset{(252.4)}{-266.2}\ SDR$$

$$- \underset{(2.333)}{3.451}\ WSTOCKW - \underset{(27.57)}{60.27}\ Q2 + \underset{(49.6)}{101.1}\ Q3 + \underset{(31.43)}{12.98}\ Q4$$

$R^2 = .79$ $\bar{R}^2 = .73$ DW = 1.86 $\sigma = 53.48$ PRMSE = 23.8 1969 I/1977 II

$$PWPR = (\underset{(139.0)}{965.1} + \underset{(226)}{1392}\ MNWHT - \underset{(5.571)}{5.375}\ DIVWHT)\ Q3$$

$R^2 = .98$ $\bar{R}^2 = .98$ DW = 2.00 $\sigma = 92.15$ PRMSE = 22.70 1964 I/1977 IV

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a/Terms defined at end of this table.

TABLE 1
(continued)

Corn Market Behavioral Equations

$$QDCRN = \underset{(416.88)}{-53.85} - \underset{(.10733)}{0.0167}\, QDCRN_{t-1} - \underset{(6267)}{3288}\, (PCRN/WPI)^{.875} + \underset{(.1431)}{.4412}\, DI_{72}$$

$$+ \underset{(10.63)}{21.40}\, GCAU - \underset{(45.4)}{375.1}\, Q2 - \underset{(71.3)}{126.3}\, Q3 + \underset{(53.9)}{158.3}\, Q4$$

$R^2 = .73$ $\bar{R}^2 = .71$ DW = 1.95 $\sigma = 140.38$ PRMSE = 14.5 1957 IV/1979 III

$$STCRN = \underset{(317.4)}{404.8} + \underset{(.0559)}{.6898}\, STCRN_{t-1} - \underset{(14589)}{67460}\, (PCRN/WPI)^{1.125} + \underset{(.0488)}{0.7701}\, PCPR$$

$$- \underset{(.4655)}{.5174}\, FORCRN + \underset{(93.5)}{204.2}\, Q2 - \underset{(135.0)}{643.2}\, Q3 - \underset{(318.6)}{128.8}\, Q4$$

$R^2 = .996$ $\bar{R}^2 = .995$ DW = 1.25 $\sigma = 104.47$ PRMSE = 3.9 1969 I/1978 II

$$EXCRN = \underset{(398)}{1412} + \underset{(.1545)}{.3408}\, EXCRN_{t-1} - \underset{(1.821 \times 10^{18})}{3.666 \times 10^{18}}\, (PCRN/WPI)^{9.5} - \underset{(344)}{1269}\, SDR$$

$$- \underset{(7.513)}{7.974}\, WSTOCKC - \underset{(45.5)}{119.6}\, Q2 + \underset{(54.7)}{181.7}\, Q3 + \underset{(33.73)}{32.61}\, Q4$$

$R^2 = .83$ $\bar{R}^2 = .79$ DW = 2.31 $\sigma = 60.14$ PRMSE = 23.1 1969 I/1977 II

$$PCPR = (\underset{(950)}{3279} + \underset{(800)}{2194}\, MNCRN - \underset{(14.75)}{23.70}\, DIVCRN)\, Q4$$

$R^2 = .98$ $\bar{R}^2 = .98$ DW = 1.95 $\sigma = 304.51$ PRMSE = 24.5 1964 I/1977 IV

TABLE 1
(continued)

Cattle Market Behavioral Equations

$$QDCOW = (\underset{(32.4)}{141.4} - \underset{(32.99)}{96.84} \left(\frac{RCOW}{WPI}\right)^{.125} + 12.85 \frac{RHOG}{WPI} \quad 6.645 \frac{RBRL}{WPI}$$

$$- \underset{(.8215)}{.3276} Q2 + \underset{(.8207)}{.8769} Q3 + \underset{(.8165)}{.9306} Q4) DI_{72}^{.7}$$

$R^2 = .90 \quad \bar{R}^2 = .89 \quad DW = .42 \quad \sigma = 271.67 \quad PRMSE = 6.28 \quad$ 1954 I/1978 IV

$$QSCOW = \underset{(259)}{2609} + \underset{(44.6)}{504.0} BFFEED_{t-2} - \underset{(188)}{1200} Q2 + \underset{(156.2)}{333.7} Q3 + \underset{(160.5)}{515.5} Q4$$

$R^2 = .64 \quad \bar{R}^2 = .62 \quad DW = .51 \quad \sigma = 481.80 \quad PRMSE = 9.9 \quad$ 1960 III/1979 III

$$BFFEED = - \underset{(1.277)}{4.763} + \underset{(2.729)}{3.632} \frac{PCOW}{WPI} - \underset{(56.7)}{108.5} \frac{PCRN}{WPI} + \underset{(.0333)}{.1077} BFINV_{t-3}$$

$$+ \underset{(.0935)}{.6244} BFFEED_{t-1} + \underset{(.328)}{1.501} Q2 + \underset{(.346)}{2.448} Q3 + \underset{(.291)}{4.225} Q4$$

$R^2 = .90 \quad \bar{R}^2 = .89 \quad DW = 2.35 \quad \sigma = .575 \quad PRMSE = 10.40 \quad$ 1960 II/1978 IV

$$BFINV = - \underset{(.2347)}{.6610} + \underset{(1.097)}{6.743} \frac{PCOW}{WPI} + \underset{(.0047)}{.9803} BFINV_{t-1} - \underset{(.08532)}{.08206} Q2$$

$$- \underset{(.08495)}{.05246} Q3 - \underset{(.08514)}{.02085} Q4$$

$R^2 = .998 \quad \bar{R}^2 = .998 \quad DW = .35 \quad \sigma = .297 \quad PRMSE = .89 \quad$ 1954 II/1978 IV

TABLE 1
(continued)

Hog Market Behavioral Equations

$$QDHOG = (\underset{(7.83)}{-83.01} + \underset{(5.74)}{69.98}\left(\frac{RHOG}{WPI}\right)^{-.75} + 12.85\frac{RCOW}{WPI} + 35.68\frac{RBRL}{WPI}$$

$$- \underset{(1.164)}{3.985}\,Q2 - \underset{(1.184)}{3.120}\,Q3 + \underset{(1.157)}{2.663}\,Q4)\,DI_{72}^{.7}$$

$R^2 = .59$ $\bar{R}^2 = .57$ DW = .86 $\sigma = 385.01$ PRMSE = 11.4 1954 I/1978 IV

$$QSHOG = \underset{(432)}{1673} - \underset{(16227)}{56656}\frac{PCRN}{WPI} + \underset{(6.40)}{51.42}\,STPIGM_{t-1} - \underset{(67.7)}{176.9}\,Q2$$

$$- \underset{(67.7)}{348.7}\,Q3 + \underset{(69.3)}{203.3}\,Q4$$

$R^2 = .79$ $\bar{R}^2 = .77$ DW = .98 $\sigma = 182.05$ PRMSE 5.30 1964 II/1978 IV

$$STPIGM = -\underset{(4.824)}{3.644} + \underset{(11.47)}{22.25}\frac{PHOG}{WPI} - \underset{(183.5)}{144.6}\frac{PCRN}{WPI} + \underset{(.637)}{3.659}\,STPIGB_{t-2}$$

$$- \underset{(40281)}{16400}\,SIGCRN + \underset{(.0969)}{.3458}\,STPIGM_{t-1} + \underset{(.5770)}{.1133}\,Q2 + \underset{(.604)}{1.038}\,Q3 + \underset{(.629)}{1.384}\,Q4$$

$R^2 = .87$ $\bar{R}^2 = .85$ DW = 1.11 $\sigma = 1.524$ PRMSE = 3.11 1964 III/1978 IV

$$STPIGB = \underset{(1.109)}{3.265} + \underset{(2.490)}{3.862}\frac{PHOG}{WPI} - \underset{(42.2)}{115.6}\frac{PCRN}{WPI} - \underset{(9147)}{18406}\,SIGCRN$$

$$+ \underset{(.0911)}{.6733}\,STPIGB_{t-1} + \underset{(.1303)}{.2628}\,Q2 + \underset{(.1308)}{.5485}\,Q3 + \underset{(.1299)}{.2977}\,Q4$$

$R^2 = .80$ $\bar{R}^2 = .77$ DW = 1.91 $\sigma = .340$ PRMSE = 3.87 1964 II/1974 IV

TABLE 1
(Continued)

Poultry Market Behavioral Equations

$$QDBRL = \Big(\underset{(.752)}{4.754} - \underset{(4.31)}{44.64}\left(\frac{RBRL}{WPI}\right)^{1.875} - 6.645\ \frac{RCOW}{WPI} + 35.68\ \frac{RHOG}{WPI}$$

$$+ \underset{(.369)}{1.930}\ Q2 + \underset{(.368)}{1.255}\ Q3 - \underset{(.3734)}{.2258}\ Q4\Big)\ DI_{72}^{.7}$$

$R^2 = .63 \quad \bar{R}^2 = .61 \quad DW = .43 \quad \sigma = 113.37$ PRMSE = 6.9 1960 I/1978 IV

$$QSBRL = \underset{(118)}{-2860} - \underset{(5666)}{3603}\ \frac{PCRN}{WPI} + \underset{(44)}{2231}\ PTPLT + \underset{(423.1)}{383.6}\left(\frac{PBRL}{WPI}\right)_{t-1}$$

$$- \underset{(3760)}{17695}\left(\frac{PCRN}{WPI}\right)_{t-1} + \underset{(19.5)}{182.4}\ Q2 + \underset{(19.3)}{191.4}\ Q3 + \underset{(20.56)}{25.26}\ Q4$$

$R^2 = .99 \quad \bar{R}^2 = .98 \quad DW = .86 \quad \sigma = 58.10$ PRMSE = 3.54 1960 I/1978 IV

Livestock-Feed Demand Relationship

$$GCAU = \underset{(.1624)}{.3904}\ (BFFEED_{t-1} + BFFEED_{t-2}) + \underset{(.0263)}{.6009}\ (STPIGB_{t-1} + STPIGM_{t-1})$$

$$+ \underset{(.00086)}{.00141}\ QSBRL$$

$DW = .37 \quad \sigma = 2.368$ PRMSE = 5.6 1964 II/1979 III

TABLE 1
(Continued)

Livestock Marketing Margin Relationships

$$MARCOW = .1662 + .00007366\ QSCOW + .4209 \frac{RCOW}{WPI} + 12.98 \frac{ULCP}{WPI}$$
$$(.0509)\quad (.00001265)\qquad (.0795)$$

$$- .00006268\ QSCOW_{t-1}$$
$$(.00001200)$$

$R^2 = .68$ $\bar{R}^2 = .66$ DW = .86 $\sigma = .0284$ PRMSE = 4.47 1954 I/1978 IV

$$MARHOG = .09601 + .000006093\ QSHOG + .3714 \frac{RHOG}{WPI} + 44.34 \frac{ULCP}{WPI}$$
$$(.04603)\quad (.000006503)\qquad (.0490)\qquad (11.43)$$

$$- .00002671\ QSHOG_{t-1}$$
$$(.00000475)$$

$R^2 = .61$ $\bar{R}^2 = .59$ DW = .85 $\sigma = .0211$ PRMSE = 4.56 1954 II/1978 IV

$$MARBRL = .02898 + .3417 \frac{RBRL}{WPI} + 27.77 \frac{ULCP}{WPI} - .00002450\ QSBRL_{t-1}$$
$$(.04810)\qquad (6.85)\qquad (.00000656)$$

$R^2 = .74$ $\bar{R}^2 = .73$ DW = 1.40 $\sigma = .0145$ PRMSE = 6.07 1960 II/1978 IV

TABLE 1
(continued)

Identities

$$QDWHT + STWHT + EXWHT + GOVWHT + FORWHT$$

$$= PWPR + STWHT_{t-1} + GOVWHT_{t-1} + FORWHT_{t-1}$$

$$QDCRN + STCRN + EXCRN + GOVCRN + FORCRN$$

$$= PCPR + STCRN_{t-1} + GOVCRN_{t-1} + FORCRN_{t-1}$$

$$QDCOW = QSCOW$$

$$QDHOG = QSHOG$$

$$QDBRL = QSBRL$$

$$MNWHT = MAX \quad 1/3 \sum_{k=1}^{3} \left(\frac{PWHT}{WPI}\right)_{t-4k} YWHT_{t-4k}, \quad \frac{LRWHT}{WPI} \; 1/3 \sum_{k=1}^{3} YWHT_{t-4k}$$

$$MNCRN = MAX \quad 1/3 \sum_{k=1}^{3} \left(\frac{PCRN}{WPI}\right)_{t-4k} YCRN_{t-4k}, \quad \frac{LRCRN}{WPI} \sum_{k=1}^{3} YWHT_{t-4k}$$

$$SIGRN = 1/12 \sum_{k=1}^{12} \left(\frac{PCRN}{WPI}\right)_{t-k} - MNC$$

$$MNC = 1/12 \sum_{k=1}^{12} \left(\frac{PCRN}{WPI}\right)_{t-k}$$

$$MARCOW = \frac{RCOW}{WPI} \quad \frac{PCOW}{WPI}$$

$$MARHOG = \frac{RHOG}{WPI} \quad \frac{PHOG}{WPI}$$

$$MARBRL = \frac{RBRL}{WPI} \quad \frac{PBRL}{WPI}$$

TABLE 1
(continued)

a/Note that numbers in parentheses are standard errors estimated subject to nonlinear parameter estimates. Definitions of endogenous variables are as follows:

QDWHT = Domestic disappearance of wheat, mil. bu. (WS)
STWHT = Market stock of wheat, mil. bu. (WS)
EXWHT = Exports of wheat, mil. bu. (WS)
PWPR = Domestic production of wheat, mil. bu. (WS)
PWHT = Price of wheat, $/bu., farm level (AGP)
QDCRN = Domestic disappearance of corn, mil. bu. (FDS)
STCRN = Market stock of corn, mil. bu. (FDS)
EXCRN = Exports of corn, mil. bu. (FDS)
PCPR = Domestic production of corn, mil. bu. (CRP)
PCRN = Price of corn, $/bu., farm level (AGP)
QSCOW = Quantity supplied of beef and veal, mil. lbs. (LMS)
QDCOW = Quantity demanded of beef and veal, mil. lbs. (Identity)
BFFEED = Cattle placed on feed, 23 States, mil. hd. (COF)
BFINV = Stock of beef cows, mil. hd., interpolated from January 1 data (CTL)
PCOW = Price of all beef cattle, $/cwt., farm level (AGP)
RCOW = Retail price of beef, $/cwt. (BLS)
MARCOW = Beef retail/farm level marketing margin, $/cwt. (Identity)
QSHOG = Quantity supplied of pork, mil. lbs. (LMS)
QDHOG = Quantity demanded of pork, mil. lbs. (Identity)
STPIGM = Stock of pigs kept for market, mil. hd. (CEA)
STPIGB = Stock of pigs kept for breeding, mil. hd. (CEA)
PHOG = Price of hogs, $/cwt., farm level (AGP)
RHOG = Retail price of pork, $/cwt. (BLS)
MARHOG = Pork retail/farm level marketing margin, $/cwt. (Identity)
QSBRL = Federally inspected broiler production or quantity supplied, mil. lbs., R-T-C weights (PES)
QDBRL = Quantity demanded of broiler production, mil. lbs. (Identity)
PBRL = Price of broilers, $/cwt., farm level (AGP)
RBRL = Price of frying chicken, $/cwt., retail level (BLS)
MARBRL = Poultry retail/farm level marketing margin, $/cwt. (Identity)
GCAU = Grain consuming animal units (CEA)
MNWHT = Subjective returns per acre for wheat adjusted rationally to changes in loan rate (Identity)

TABLE 1
(continued)

MNCRN = Subjective returns per acre for corn adjusted rationally to changes in loan rate (Identity)
SIGCRN = Subjective variance of corn price for use in livestock feed (Identity)
MNC = Subjective mean of corn price used in determining SIGCRN (Identity)

Definitions of exogenous variables are as follows:

DI_{72} = Disposable income in 1972 dollars (BLS)

WPI = Wholesale price index, 1967 = 100 (BLS)

SDR = Special drawing rights per dollar exchange rate (IMF)

PTPLT = Productivity trend for poultry (CEA)

ULCP = Private unit labor costs (BLS)

GOVWHT = Beginning Government-owned stocks of wheat, mil. bu. (USDA)

GOVCRN = Beginning Government-owned stocks of corn, mil. bu. (USDA)

FORWHT = Beginning farmer-owned reserves of wheat under the Food and Agriculture Act of 1977, mil. bu. (GAO)

FORCRN = Beginning farmer-owned reserves of corn under the Food and Agriculture Act of 1977, mil. bu. (GAO)

WSTOCKW = Beginning stocks of wheat in non-U.S. wheat exporting countries at beginning of quarter (GB)

WSTOCKC = Beginning stocks of corn in non-U.S. corn exporting countries at beginning of quarter (GB)

LRWHT = Wheat loan rate, $/bu. (WS)

LRCRN = Corn loan rate, $/bu. (FDS)

DIVWHT = Wheat acreage diverted or set aside under Government programs, mil. a. (CEA)

DIVCRN = Corn acreage diverted or set aside under Government programs, mil. a. (CEA)

Q2 = Second quarter indicator variable

TABLE 1
(continued)

Q3 = Third quarter indicator variable
Q4 = Fourth quarter indicator variable

Sources of data indicated in parentheses above are defined as follows:

(WS) - Wheat Situation, Economic Research Service, USDA.
(AGP) - Agricultural Prices, Statistical Reporting Service, USDA.
(FDS) - Feed Situation, Economic Research Service, USDA.
(CRP) - Crop Production, Statistical Reporting Service, USDA.
(LMS) - Livestock and Meat Situation, Economic Research Service, USDA.
(COF) - Cattle on Feed, Statistical Reporting Service, USDA.
(CTL) - Cattle, Statistical Reporting Service, USDA.
(BLS) - Consumer Price Index, Bureau of Labor Statistics, USDL.
(CEA) - Chase Econometrics Associates, Inc.
(PES) - Poultry and Egg Situation, Economic Research Service, USDA.
(IMF) - International Financial Statistics, International Monetary Fund.
(USDA) - Unpublished data obtained from USDA.
(GAO) - Available through GAO as part of this project.
(GB) - Grain Bulletin, Great Britain Commonwealth Secretariat, Commodities Division.

Turning to the demand side of the model, the estimates in table 1 suggest some interesting characteristics of grain demand in the context of nonlinearity. First of all, the grain export equations are highly nonlinear and, perhaps surprisingly, turn down at larger quantities. In fact, export demand becomes almost perfectly inelastic at low prices but is much more responsive at high prices. The important implication of this result for stabilization policy in contrast to linear models is that stock accumulation can very quickly depress prices to support levels when the reserve becomes too large.

The results relating to nonlinearity of the private stock demand equations are also somewhat surprising. A common belief in the literature is that the relationship between stocks and prices is highly nonlinear but with an upward curvature so that prices do not fall much at large stock levels but rise sharply when stocks are low. 1/ The results here, however, suggest a downward curvature in which large stocks cause sharp declines in prices; large stocks apparently tend to cause buyers to regard the market as glutted. Actually, when the private stock relationships were estimated without considering response of private storage to public stocks and farmer-owned reserve levels in this study, both the corn and wheat stock equations took on the usual upward curving shape. The estimated exponents for price were .625 for wheat stocks and -.125 for corn stocks. With Government and farmer-owned reserve levels in the equations, however, the estimated exponents became 1.125 in each case. 2/ The curvature is downward

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1/See T.N. Barr, "Demand and Price Relationships for the U.S. Wheat Economy," Wheat Situation WS-226 (1973), pp. 15-25.

2/The initial estimate for the wheat stock equation exponent was even higher, 2.25, but this estimate had to be adjusted downward for purposes of obtaining sufficient market stability for the following analyses. That is, in the process of model validation (not discussed in detail here), it became clear that the version of the model based on the coefficient of 2.25 was rather unstable. Furthermore, the likelihood function for this equation was almost insensitive to changes in the nonlinear wheat stock price parameter between 1.125 and 2.25. Hence, the estimates in table 1 are conditioned on the parameter estimate 1.125 which leads to greater stability of the system. Such an adjustment was not made for any other parameter estimate.

bending if the exponent is greater than 1 and upward bending if the exponent is less than 1. 1/

The fact that including response of private storage to public stock policy causes this switch in curvature suggests that Government programs have been primarily responsible for price support at large stock levels. Private concerns may not keep prices from falling quite as low in the absence of Government price support when stock levels are large. Thus, the estimated stock equations, like the estimated export equations, suggest that stock accumulation in the U.S. grain economy may carry a high risk of either price depression or high Government costs in avoiding price depression.

The magnitudes of the estimated coefficients of the farmer-owned reserve are of further interest in examining the effectiveness of the farmer-owned reserve program. In particular, the coefficient of -.8095 on the wheat farmer-owned reserve indicates that other private stocks are reduced by nearly 81 percent of any increase in farmer-owned reserve. This is in sharp contrast to the coefficient of -.04358 for Government-owned stocks; that is, private stocks are reduced by only a little over 4 percent of any increase in CCC holdings. Furthermore, these differences are quite significant as evidenced by the small standard errors of coefficients.

If one goal of the agricultural policy is to maintain an effective emergency food reserve, then these results imply that the farmer-owned reserve is a very inefficient means of doing so. 2/ According to these estimates, the Government must pay storage costs on 5.51 bushels to actually increase total stock holdings by 1 bushel. On the other hand, Government-owned stocks must only be increased by 1.05 bushels to increase total stock holdings

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1/This may be simply verified by computing second derivatives of the demand equations with respect to price.

2/As pointed out by Daniel Sumner in his review of this report, these results may not be so critical of the farmer-owned reserve as they are of the way it was managed. If rules governing the farmer-owned reserve could be determined so that it would behave as the CCC would have behaved, then it would be no better or worse. However, this study is based on historical data and thus compares operations of the farmer-owned reserve with those of the CCC as stocks were actually managed in each case historically.

by 1 bushel. Thus, to establish a given emergency food stock in addition to usual levels of market stocks costs the Government more than five times as much in storage costs as if stocks are held instead by the CCC. The reason for this great difference is apparently that market participants regard farmer-owned reserves as a very close substitute for market stocks in meeting unexpected short-term needs, whereas CCC stocks are regarded as much less accessible and thus as less of a substitute. For example, CCC stocks may be depleted through Public Law 480 shipments or other Government food aid projects which are not anticipated at harvest time. Perhaps, since decisions regarding release of the farmer-owned reserve are in the hands of farmers rather than Government, grain buyers view those stocks as responding faster to unanticipated market developments. Perhaps also there is more displacement under the farmer-owned reserve since the farmers holding the reserve are more likely to be the ones holding market stocks in the absence of a farmer-owned reserve.

Estimates for the corn farmer-owned reserve have similar qualitative implications but the magnitudes are much less certain. The coefficient of -.5174 implies that only about 2 bushels of stocks must be held in the farmer-owned reserve to increase total stocks by 1 bushel. But the standard error in this case is quite large. Furthermore, Government-owned stocks when included in the equation had an implausible (but insignificant) positive sign. But neither of these results are statistically inconsistent with the rather precise results obtained for wheat.

Turning to the livestock model, the crucial aspects for this study have to do with the grain-livestock market linkages. Corn price is used as a proxy for feed price in the livestock supply models, while the number of grain consuming animal units is used as the determinant of grain demand for feed. Since wheat feed use often constitutes only a residual part of feed supply, wheat price is not used as a determinant in the livestock supply equations even though livestock numbers affect wheat demand for feed substantially.

Corn price appears to play a strong role in decisions to place beef cattle on feed, to change the stock of pigs held for breeding, and to raise broilers (the latter is represented by a lagged corn price in the broiler supply equation). Likewise, the number of livestock on feed (represented by grain consuming animal units) appears to play a strong role in determining corn demand. The much weaker role of livestock numbers in wheat demand is presumably due to wheat's relative unimportance as a feed as well as its somewhat intermittent use for that purpose.

The nonlinear estimates of meat demand are also interesting. 1/ First of all, the poultry-meat demand equation has a downward curvature. Thus, as poultry prices become high (relative to beef and pork), consumers increasingly substitute other commodities--presumably beef and pork. On the other hand, as poultry prices get low, consumers tend to reach saturation and demand becomes sharply inelastic. With beef and pork, on the other hand, demand turns upward so that consumers are reluctant to give up all beef and pork consumption at high prices while quantities increase sharply at low prices. While not directly obvious from the esti-

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1/The specification of meat demand is based on a consumer indirect utility function of the form

$$V = \alpha_1 P_b^{\delta_1} + \alpha_2 P_h^{\delta_2} + \alpha_3 P_p^{\delta_3} + \alpha_4 m^{\delta_4} + \alpha_5 P_b P_h + \alpha_6 P_b P_p + \alpha_7 P_h P_p$$

where P_b, P_h, and P_p are prices of beef, pork, and poultry, respectively, deflated by a basket price, and m is consumer income relative to the basket price. The demand equation specifications follow through explication of Roy's identity in which demand for, say, beef is given by

$$X = -\frac{\partial V/\partial P_b}{\partial V/\partial m}$$

The reader may note similar justification can be used for the grain demand equations as well where indirect utilities are of the form

$$V = \alpha_1 p^{\delta_1} + \alpha_2 X_p + m^{\delta_2}$$

for grain disappearance and

$$V = \alpha_1 p^{\delta_1} + \alpha_2 X_p + \alpha_2 mp, \ m=0$$

for grain stocks and exports with X representing the role of an exogenous variable. With these specifications, the exact compensating variations can be estimated for purposes of welfare analysis; thus, the results do not rely on the usual arguments of approximation of ordinary consumer surplus for compensating variation. Note, however, that the grain disappearance demands were linearized with respect to income for purposes of estimation.

mates, substitution of actual price levels reveals that the upward curvature for beef is about four times that of pork (as measured by second derivatives). Thus, as one would expect, beef appears to be a more preferred good (followed by pork and then poultry) in the sense that its consumption ultimately increases more at low prices (or high incomes). Again, these results suggest the importance of adequate consideration of nonlinearity in reflecting realistic relationships which, as shown earlier, have a bearing on the effects of price stabilization.

One final note is needed before proceeding to the analysis of the farmer-owned reserve policy. To examine the issue of disturbance form in the context of the earlier discussion, the residuals from estimated relationships were computed. The squares of these were then regressed on squares of predicted dependent variables following equation (2). As in previous work, this exercise did not conclusively support either additive or multiplicative disturbances. As a result, the analyses in this study were carried out under both specifications. Because of the magnitudes of changes involved, this change in specification had only negligible effects on results. Since results are almost the same for the two specifications, only those associated with additive disturbances are presented below.

Aside from these considerations, the statistical fit in table 1 is generally good and standard errors of most economic variables are small relative to estimated coefficients. The fit on the crucial production and stock equations for the grains is particularly good in terms of R^2; the high percentage-root-mean-squared errors (PRMSE) for production are due to the very risky nature of agricultural crop yields. The Durbin-Watson statistics (which may be biased for this application) are all in a satisfactory range for the grain sector and are low, suggesting serial correlation in the livestock sector essentially only in equations with very low PRMSEs where the consequences are less important.

While the necessity for brevity in this report prevents reporting the model validation work which was undertaken in examining properties of the estimated model, the PRMSEs provide useful evidence in the context of the sample period and are comparable with those obtained in other econometric studies of these agricultural sectors. In addition, a number of simulations beyond the sample period were performed. The simulations that involved actual and forecasted post-sample data for the exogenous variables generally indicated that the model behaved in a reasonable and stable manner over near time horizons. When these simulations were performed with widely different values for some of the exogenous variables, however, somewhat peculiar results were obtained beyond 6 to 10 quarters. Such results are not uncommon for models with so many dynamic relationships as this one. But upon comparison with other models in the literature, these model validation results have further interesting implications.

That is, the model estimated here follows the same essential structure as in previous studies aside from the generality of functional forms considered here. Consider, for example, the beef market. The meat demand equations involve the same variables as used by Arzac and Wilkinson. 1/ Furthermore, the income elasticity was chosen to correspond roughly to their results. The difference lies in the curvature allowed in the functional forms used here, whereas linearity is arbitrarily imposed by Arzac and Wilkinson. The margin equations used here also follow the same essential specification used by Arzac and Wilkinson except that a quantity variable is added to allow some response elasticity by the processing sector (i.e., the possibility of a nonconstant margin). The beef meat supply equation follows Arzac and Wilkinson except that insignificant variables are not included. The cattle-placed-on-feed equation follows Arzac and Wilkinson except that a different variable is used to represent calves available. The beef cattle inventory equation follows Arzac and Wilkinson except that a single price rather than a lag distribution of prices is used to represent cattle price effects. Other equations in the livestock sector are specified with variables similar to those used by Arzac and Wilkinson to the extent that data were available within the context of this study. Similarly, the specifications of the wheat and corn markets are essentially the same as used by Chambers and Just 2/ except that farmer-owned reserve variables are added and functional forms have been generalized with respect to nonlinearity.

1/Arzac and Wilkinson, *op. cit.* Because the econometric work in this study had to be completed in a very short time (on the order of weeks) to allow time for the rest of the study, a decision was made to follow the structure of existing models (aside from functional flexibility) as much as possible after considering data availability in the Chase Econometrics system (which was the system made available for the empirical work).

2/Robert G. Chambers and Richard E. Just, "A Dynamic Analysis of Effects of Exchange Rate Changes on U.S. Agriculture," *American Journal of Agricultural Economics*, Vol. 63 (1981), forthcoming.

With the similarity in variables used here and elsewhere, one must conclude that unusual behavior in this model--if it occurs--is due to the functional generalities. That is, since functional specificity is imposed by other studies arbitrarily, one must consider that the conservative behavior of other models may be misleading, that other functional specificities may also lead to plausible but different results, and that the precision in a functionally more general model such as this one may be more representative of what is known about market behavior. For example, perhaps very little is known about whether grain demand would become more or less elastic at low prices in absence of Government controls since Government price supports have prevented observation of such a situation for several decades. With this in mind, somewhat noisy predictions should be expected and would, in fact, be the reasonable result in simulating low price situations in absence of price supports; by contrast, usual formulations which assume constant elasticities or constant slopes would give a false sense of security in model simulations. This must be borne in mind in examining the results below because the effects of the farmer-owned reserve are derived by comparing with the case of no Government-connected reserves and thus no price supports.

SECTION 10

AN EVALUATION OF THE EFFECTS OF THE FARMER-OWNED RESERVE PROGRAM UNDER THE FOOD AND AGRICULTURE ACT OF 1977

Based on the econometric model developed in table 1, this section turns to use of the model in gaining insight into effects, both direct and indirect, of the farmer-owned reserve program. The analysis in this section is based on the actual exogenous and random forces which influenced the grain-livestock sector during the program. Since this type of analysis necessarily requires actual data, it can cover only the period for which data have come available since the program's inception. This period basically covers the 1977-78 and 1978-79 seasons. Much of the data for the 1979-80 season were unavailable at the time of this study.

To estimate the actual impact of the program, the estimated model in table 1 was fitted to actual data for the eight quarters from 1977 III to 1979 II. 1/ That is, residuals were determined that would make the model generate the exact grain-livestock prices and quantities observed in 1977 III to 1979 II. Then, using these residuals, the model was simulated in absence of the farmer-owned reserve program (and accompanying loan rates) using the estimated coefficients in table 1 to determine the associated responses. 2/ Because of the interrelated nature of the three livestock and two grain markets, these adjustments had impacts throughout the system. The effects could only be determined by solving the 34-equation nonlinear model simultaneously in each of the eight one-quarter periods. Because of the recursive nature of parts of the model, however, only 11 nonlinear equations required simultaneous solution in each period; other equations could be used recursively.

Using this approach, the estimated impacts of the farmer-owned reserve program on market prices and quantities of both grain and livestock in table 2 were derived. As might be expected, the effects of the program are small in the early part of the program when the reserve was small.

1/Note that time periods are referenced quarterly with respect to calendar year so, for example, 1977 I represents January through March of 1977.

2/Thus, for purposes of performing the simulations below, the remaining errors relative to the observed real world situation are all zero.

TABLE 2

ESTIMATED PRICE AND QUANTITY EFFECTS OF THE

FARMER-OWNED RESERVE, 1977 III - 1979 II (note a)

		1977		1978				1979	
	Effect	III	IV	I	II	III	IV	I	II
	WHEAT								
1.	Price ($/bu.)	+.16	+.44	+1.10	-.08	-1.57	-2.57	-2.88	-2.71
2.	Disappearance (mil. bu.)	-3	-7	-20	-3	+17	+13	+ 15	+14
3.	Private stocks (mil. bu.)	-12	-54	-171	-289	-352	-395	-429	-459
4.	Exports (mil. bu.)	—	—	—	—	—	+10	+13	+24
5.	Production (mil. bu.)	—	—	—	—	+16	—	—	—
6.	F.O.R. (mil. bu.)	+15	+64	+201	+317	+382	+400	+405	+403
7.	Total stocks (mil. bu.)	+3	+10	+30	+28	+30	+15	-24	-56
	CORN								
8.	Price ($/bu.)	—	+.03	+.16	+.66	+1.02	-.99	-1.64	-1.86
9.	Disappearance (mil. bu.)	—	+2	-17	-49	-100	-122	-149	-193
10.	Private stocks (mil. bu.)	—	-7	-42	-191	-463	-437	-354	-232
11.	Exports (mil. bu.)	—	—	—	-1	—	+9	+60	+252
12.	Production (mil. bu.)	—	—	—	—	—	+11	—	—
13.	F.O.R. (mil. bu.)	—	+5	+57	+257	+629	+728	+733	+552
14.	Total stocks (mil. bu.)	—	-2	+15	+66	+166	+291	+379	+320
	CATTLE								
15.	Price ($/cwt.)	—	+.02	+.36	+2.09	+5.61	+16.97	+32.94	-23.42
16.	Marketing (mil. lb.)	—	—	+1	-9	-39	-177	-330	+188
17.	Placed on feed (mil. hd.)	—	—	-.1	-.4	-.7	+.4	+1.6	+1.5
18.	Cattle on farms (mil. hd.)	—	—	—	+.1	+.3	+.8	+1.8	+1.0
	HOGS								
19.	Price ($/cwt.)	—	+.17	+1.36	+4.36	+7.92	+1.64	+2.96	+1.16
20.	Marketing (mil. lb.)	—	-10	-70	-226	-433	-113	-150	-344
21.	Kept for market (mil hd.)	—	-.4	-1.0	-3.1	-7.2	-11.1	-16.4	-17.6
22.	Kept for breeding (mil. hd.)	—	-.5	-1.3	-2.1	-3.4	-3.2	-3.2	-2.6
	POULTRY								
23.	Price ($/cwt.)	—	+.23	+1.82	+6.02	+12.35	+2.24	-7.18	+1.93
24.	Marketing (mil. lb.)	—	-1	-5	-22	-51	-34	+107	+149

a/Note that blanks indicate zero or negligible values.

Generally, the early effects during the first year of the program were to increase grain prices, reduce grain consumption, and reduce private grain stock levels. As suggested by the earlier discussion, much of the reduction in private stocks is in direct response to the accumulation of the farmer-owned reserves. However, the ratio of farmer-owned reserve to change in total stock level is somewhat larger in table 2 than implied by the structural coefficients in table 1. Apparently considering price adjustments and adjustments in other demands and other markets, the farmer-owned wheat reserve actually had to increase by far more than the 5.25 bushels suggested by the impact effect discussed above in order to increase total wheat stocks by 1 bushel (compare rows 6 and 7 in table 2). In fact, this ratio gets much higher in 1979. For corn, this ratio also varies generally above that which is suggested by the structural estimates. These differences result from considering extended market effects as well as price adjustment in response to increased demand for stocks.

The most interesting aspect of the results in table 2 is that the grain price supporting effects of the reserve during the first year of the program quickly turn into price depressing effects. These effects are hard to explain in the context of the wheat and corn markets alone. One would think that the high farmer-owned reserve level tends to depress price in the second year but these effects are largely offset by lower private stocks. The explanation lies in the related markets. The higher prices in the first year and through 1978 III, particularly for corn, led to a reduction in cattle placed on feed and in numbers of hogs kept for both marketing and breeding compared with a free market case without a farmer-owned reserve. These reductions caused a tendency toward higher livestock prices. Then these upward livestock price pressures along with reduced corn price tendencies eventually caused cattle numbers to increase above free market levels and the negative effects on hog numbers kept for breeding to reverse. But these effects follow long delays required to raise breeding stock to maturity in the livestock industry. In the meantime, the earlier decisions to reduce livestock numbers compared with free market levels reduce the availability of feeder cattle and pigs for market. Thus, grain consuming animal units are reduced below free market levels for a fairly long period of time. This sustained reduction explains the lower demand for grain and thus lower prices resulting in the second year of the program as compared with the free market case. This is the case for wheat as well as corn.

Although wheat price does not play an important role in determining livestock production decisions, the residual market for wheat as feed is important in keeping wheat prices in line with corn prices. In fact, the relative effect of grain consuming animal units on wheat demand estimated in table 1 is almost as great as for corn. An additional factor which tends to make wheat prices respond to the farmer-owned reserve more than corn prices is the relatively greater estimated sensitivity of private wheat stocks to the quantity held in the farmer-owned reserve.

While the results in table 2 indicate directional impacts of the farmer-owned reserve program which after careful analysis are plausible, they give limited information about whether the program objectives of stabilizing prices, providing reasonable prices for consumers, combating inflation, etc., are achieved. 1/ To examine the stabilizing influence of the program, table 3 is constructed using the actual prices under the farmer-owned reserve and the estimated prices under the free market case associated with table 2. These results show that while the program had the somewhat unexpected effect of depressing grain prices, it also served to increase livestock prices and to stabilize prices in both grain and livestock markets (except for the hog market where instability changed negligibly). Thus, the objective of stabilization was apparently achieved during the first 2 years of the program. The effects on consumer prices, however, are conflicting. Grain prices were lowered but livestock prices increased.

The above results indicate impacts on prices and quantities associated with the farmer-owned reserve. But the more important impacts on real income of producers and consumers are not clear without further analysis. For example, a high grain price is not of as much benefit if a farmer has less of

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1/While the directional impacts are plausible, the large magnitude of change for prices in the last 3 quarters of the 2-year period covered by table 2 are somewhat questionable. It should be noted, however, that experimentation with several alternative specifications of the model admitting the necessary flexibilities discussed in sections 3 to 7 led to the same directional impacts with equally large or larger magnitudes. It should also be noted that the model validation work discussed above appropriately raises reservations regarding results beyond 6 quarters (1978 IV) for some equations. While the less stable forecasts generated from the flexible type of model used here may overstate program effects at least in later periods, the theoretical results above imply that a traditional linear or log-linear model can understate effects.

TABLE 3

COMPARISON OF PRICE LEVELS AND STABILITY

WITH AND WITHOUT THE FARMER-OWNED RESERVE

1977 III - 1979 II (note a)

Market	Actual With the Farmer-Owned Reserve	Estimated Without the Farmer-Owned Reserve
Wheat ($/bu.)	2.76 (.35)	3.78 (1.79)
Corn ($/bu.)	2.06 (.20)	2.39 (1.08)
Cattle ($/cwt.)	49.74 (12.18)	45.42 (18.92)
Hogs ($/cwt.)	47.68 (3.48)	45.23 (3.10)
Poultry ($/cwt.)	25.98 (2.46)	23.93 (5.24)

a/Numbers in parentheses are standard errors.

a crop to sell. Furthermore, a high price in the current period may induce expanded output next period just when low prices occur. In the latter case, a high price this period may have a detrimental overall impact on the producer's economic welfare when the overall impact is realized. Detrimental effects would tend to be realized when temporarily high or low prices provide false signals for producers.

The short-run real income effects on consumers and producers of the farmer-owned reserve can be estimated following the economic surplus methodology discussed earlier. In addition, changes in investment resulting from the implementation of the farmer-owned reserve program over time can be evaluated following the methodology outlined in Just, Hueth, and Schmitz. 1/ That is, where the role of lags in supply is clearly due to timelags required in production, the lag

1/R.E. Just, D.L. Hueth, and A. Schmitz, *op. cit.*, Appendix C.

coefficients can be used together with market information to estimate the amount of investment made in each lag period which first contributes to production in a current period. In evaluating the economic welfare effects of the program, one must consider not only the change in (short-run or current-period) revenues associated with changes in prices and quantities, but also the difference in investment costs resulting from implementation of the program. Considering both the short-run changes in costs and benefits as well as the changes in investment costs incurred over time, the effects associated with the changes in table 2 are estimated in table 4. The results are again somewhat surprising but consistent with the results in table 2.

Because the program acted as a price support in its first year as farmer-owned stocks were accumulated under loan, the impact (initial) effect on grain producers was an increase in real income. Wheat farmers' profits were $333 million higher and corn farmers' profits were $205 million higher than in the absence of the farmer-owned reserve (including absence of any effective loan rate). However, the higher prices supported by the farmer-owned reserve program as stocks were accumulating led to a false signal to expand grain production which would not be sustained. As a result, wheat farmers undertook an additional $75 million investment and corn farmers an additional $59 million investment to expand output for the 1978 crop year above what they would have in absence of the farmer-owned reserve. This expanded output together with grain stock levels which were higher and livestock numbers on feed which were lower than in absence of the farmer-owned reserve then led to lower prices than would have been realized in absence of the reserve. These two effects led to a substantial decline in short-run profits of $2.7 billion for wheat farmers and $7.0 billion for corn farmers in 1978 from the case with no farmer reserve. Thus, the farmer-owned reserve seems to be a case where the stock accumulation period caused false price signals for livestock industry contraction and grain market expansion so that the higher initial prices eventually worked against the grain farmers who were the intended beneficiaries.

Turning to the effects on other market groups, grain demanders are obviously adversely affected by the initial price increases but then beneficially affected by the later price declines compared with the case with no farmer-owned reserve. Estimates suggest that these early adverse effects during the 1977 crop year were more than outweighed by beneficial effects in the 1978 crop year for all grain demanders--consumers, stockholders, and foreign importers. Among these groups, the effects on foreign importers appear to be relatively small because prices were relatively low,

TABLE 4

ESTIMATED REAL INCOME EFFECTS OF THE

FARMER-OWNED RESERVE, 1977 III - 1979 II (note a)

Effect	Source	1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II	Total
		million dollars								
WHEAT										
Consumers	TOTAL	-2	-23	-39	+78	+24	+231	+369	+3881	+4519
Stockholders	TOTAL	-2	-4	-5	+2	+23	+32	+29	+23	+98
Foreign Concerns	TOTAL	---	---	-2	---	+4	+5	+4	+3	+14
Producers	SR	+333	---	---	---	-2742	---	---	---	-2409
	AC	---	---	---	---	-75	---	---	---	-75
	FOR	-32	-118	-356	-327	-187	-54	-15	+7	-1082
Government Costs	TOTAL	---	-4	-13	-20	-24	-25	-25	-25	-136
CORN										
Consumers	TOTAL	---	-2	-9	-99	-65	+61	+110	+329	+325
Stockholders	TOTAL	---	-1	-3	-7	-3	+37	+45	+38	+106
Foreign Concerns	TOTAL	---	---	---	-1	-2	+5	+4	+6	+12
Producers	SR	---	+205	---	---	---	-6988	---	---	-6783
	AC	---	---	---	---	---	-59	---	---	-59
	FOR	---	-9	-107	-454	-763	-201	-11	+427	-1118
Government Costs	TOTAL	---	---	-4	-16	-39	-46	-46	-35	-186
LIVESTOCK										
Meat Consumers	TOTAL	---	---	-2	-15	-16	-437	-2148	+10	-2608
Cattle Producers	SR	---	+1	+23	+123	+320	+982	+1376	-1034	+1791
	AC	---	---	---	---	-2	-9	+353	-82	+260
Hog Producers	SR	---	+2	+12	+41	+71	+2	+24	-107	+45
	AC	---	---	-1	-4	-13	-27	-24	-34	-163
Poultry Producers	SR	---	+5	+41	+148	+307	+44	-144	+67	+468
	AC	---	---	---	---	-3	-5	---	+3	-5
Total Grains	TOTAL	+297	+44	-538	-844	-3849	-7002	+464	+4654	-6774
Total Livestock	TOTAL	---	+8	+73	+293	+664	+550	-563	-1177	-152
Overall Net Effect b/	TOTAL	+297	+52	-465	-551	-3185	-6452	-99	+3477	-6926

a/Blanks represent zero or negligible figures. Note that Government storage costs are computed at $.25 per bushel per year on the amount in the farmer-owned reserve prorated quarterly. The source codes are defined as follows: SR = short-run profits, AC = change in investment costs (herd expansion, etc.) incurred in earlier periods which become productive (contributes to sales) in the relevant quarter (represented as a negative benefit), and FOR = dollar value of grain leaving the farmer-owned reserve (negative if entering).

b/Before correcting for the value of grain still held in the farmer-owned reserve.

particularly in real terms, so that world markets were fairly saturated and thus unresponsive to the price differentials. Stockholders were affected to a larger extent, while consumers were affected to the greatest extent.

In view of these effects, one may consider whether the farmer-owned reserve program benefited grain market participants as a whole. Aggregating the effects over all grain market participants reveals a positive net impact in the last half of 1977 and first half of 1979 but a negative effect during 1978. (See the Total Grains line in table 4.) Basically, producers' gains dominate the last two quarters in 1977 while demanding groups' gains dominate the first two quarters of 1979. However, the negative effects in 1978 more than outweigh the positive impacts in the remainder of the 2-year period. All grain market participants considered jointly suffered a loss of over $6.8 billion over the 2-year period.

In evaluating these overall effects on grain, though, one must bear in mind that farmer-owned reserve accumulation is regarded as a liability in the above calculators corresponding to the value of grain placed in reserve. The corresponding benefits are not realized until the grain is sold. But at the end of 1979 II, 250 million bushels of wheat and 586 million bushels of corn were still in the reserve. At market prices for 1979 II (which could not have been sustained in the event of a sale), these stocks were valued at $2.5 billion. Adjusting the overall grain market loss by this amount suggests a net loss of $4.3 billion over the 2-year period instead of the $6.8 billion figure above. Nevertheless, the net loss is substantial (on the order of a quarter dollar per bushel over the 2-year period). One might also note, however, that if these stocks were carried over to some later period of substantial shortage, they may be worth considerably more than $2.5 billion and thus the negative overall effect of the program could be less.

Next, consider the real income effects on livestock market participants. The directional impacts on meat consumers are fairly evident from table 2 since meat prices were affected relatively little in the earlier quarters and then were substantially higher with the farmer-owned reserve than without it with a few negative effects appearing near the end of the 2-year period. In terms of magnitudes, however, the only large effects were losses in 1978 IV and 1979 I where the differential effect of the reserve on beef prices reached its maximum. The estimated net loss in real income for meat consumers over the 2-year period amounts to $2.6 billion. 1/

These losses for meat consumers are generally due to the relative slackening of meat supply under the reserve. And, of course, the relative slackening of meat supply occurring during 1978 and early 1979 is a result again of false corn price signals in 1977 generated by accumulation of the farmer-owned reserve. That is, the initial upward pressure on corn prices, caused by taking grain off the market and putting it into the reserve, gave the livestock industry a false signal to contract because expectations of corn prices were higher than if the farmer-owned reserve had not been accumulated. 2/ To some extent the upward pressure on corn prices was counteracted by an associated upward pressure on livestock prices. Nevertheless, the effect on corn prices in the first three quarters of 1978 caused a reduction in investments (in herd expansion and cattle placed on feed) as compared with the free market case that would affect beef supply in 1979 I by $353 million over and above any increase in investment due to higher cattle prices. This effect explains the net reduction in investment in the beef sector of $260 million over the 2 years examined in table 4 compared with the case with no farmer-owned reserve. Similar effects of the differential corn price under the reserve program were also felt in the hog and poultry markets. But

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1/One should bear in mind, however, that $2.1 billion of this loss occurs in 1979 I which is beyond the 6 quarter simulation horizon in which the model validation work indicated reasonable and stable results.

2/Of course, one must bear in mind that these conclusions are based on the particular price expectation mechanisms in the estimated econometric model. Other mechanisms could conceivably generate different results but the directional impacts discussed here seem reasonable. On the other hand, if livestock producers were alert and informed enough to correctly perceive the effects of the program on feed prices, then there may have been little or no livestock industry maladjustment. Reality is likely somewhere in between this extreme and that assumed in the model of this paper where livestock producers do not perceive the short-run nature of the initial effects. In this sense, the effects estimated in tables 2 and 4 may be taken as upper bound estimates. The assumption of fully informed livestock producers seems questionable, however, when studies such as this are required to estimate the price effects that livestock producers would be assumed to know 3 years earlier.

these effects were outweighed by expanded investment associated with livestock prices that were higher with the farmer-owned reserve than without it and which were in turn partially due to the above developments in the beef market.

Short-run profits were generally higher for each of the livestock industries because livestock prices were higher with the reserve than they would have been without it. This is reasonable even though smaller quantities of livestock were sold because of the inelastic nature of demand: as quantity declines, total revenue increases. The increase in short-run profits was generally larger for cattle producers and smaller for hog producers. In fact, because of the shorter term involved for supply response in the hog industry, the higher prices under the reserve program led to increases in investments which more than outweighed the increase in short-run profits. Supply response in the poultry industry, on the other hand, is much faster; investments are relatively small with quick payoffs. Thus, the increased short-run profits easily dominate the higher investments under the reserve.

In evaluating the net effects on the livestock sector, the higher livestock prices caused shortly after the introduction of the reserve program seem to have led to increased producer short-run profits which dominated all other effects until early 1979. Substantial adverse effects on meat consumers caused by the higher prices, however, caused net effects to turn negative in 1979 I. Finally, as greater supplies hit the market in response to higher 1978 prices, the beef and pork prices began to fall; the lower producer profits thus dominated other effects in 1979 II. As one might expect, however, the net effects on the livestock sector, which are indirect effects, are secondary in importance as compared with the grain market effects. Nevertheless, it is worth noting that the net livestock sector effect over the first eight quarters of the farmer-owned reserve program was a loss of $152 million.

The overall estimated effect over the first eight quarters of the program is a loss of $6.9 billion. Reducing this loss by the value of grain still held in the reserve ($2.5 billion) thus results in an overall net loss of $4.4 billion. This result implies that some system of transfers must have existed so that all market participants would have been better off without the farmer-owned reserve program in the first 2 years. For example, meat consumers would have been better off to have compensated cattle producers and poultry producers for their losses incurred in foregoing the program so that everyone in the livestock sector would have preferred no reserve program. Therefore, the farmer-owned reserve program appears to be unjustifiable on the basis of economic performance in the first 2 years alone. It should also be noted that some experimentation with model specification has suggested that these results are quite robust at least when flexible functional forms are used for the analysis.

One must bear in mind, however, that these are effects only over the first 2 years of the program. As far as overall effects of the program are concerned, the results of this simulation imply that a steady state adjustment to the new program had not yet been reached by 1979 II and thus the long-run gains could conceivably exceed the costs. 1/ But the $4.4 billion deficit after 2 years seems hard to overcome if future periods are discounted to a very great extent. (Note that the estimates are in nominal terms so the rate of discount should be fairly high.) Thus, the dynamic problems of adjustment because of false price signals in the early periods of the program appear to have serious consequences for the overall benefits of the program.

Finally, a few words concerning the value of the results in this section are in order. This section reports the results of an empirical analysis within the confines of a presumably well-specified model, the parameters of which have been estimated with historical data. The estimated model is then used for purposes of simulating a situation unlike those for which data were available (absence of a farmer-owned reserve program, including absence of the related price supports, etc.). One must bear in mind that the results of such an exercise typically have important properties, some of which may be desirable and some of which may not. Nevertheless, the results from such a simulation can be very instructive even though they do not match any real world phenomena. For example, the results in tables 2 and 4 suggest a few price and welfare effects in later periods which seem unreasonably large although the basic story suggested by results is plausible and broadly consistent with intuition. In this case, the simulation gives a general explanation of the facts which has serious implications for agricultural policy formulation even if the magnitudes of some of the estimated effects seem too large.

1/While it would be highly desirable to examine the ultimate or steady state adjustment to the farmer-owned reserve program empirically, such an analysis is outside the scope of this study because of time constraints.

Furthermore, one must bear in mind that the farmer-owned reserve program is compared here with the case of no direct price controls of any kind. Such a market situation has not been observable in reality for decades. Thus, actual market data gives little basis for intuition regarding what magnitude of effects is plausible. While this study could have alternatively compared with a policy regime involving, say, price supports or loan rates along with set-aside requirements as had operated prior to the farmer-owned reserve program, the basis for determining the loan rates and set-aside levels that would have been adopted under such a regime is lacking. For example, one possibility is that they would have been the same as used with the farmer-owned reserve. But this would have been the case only if Government would have been willing to accumulate stocks rapidly during the 1977-78 crop year. And if this had been the case, then the the effects under the farmer-owned reserve would have been very much like those that would have existed otherwise because the distinguishing feature of the farmer-owned reserve program--the release and call levels--did not play a role until 1979.

SECTION 11

THE SOVIET GRAIN SALES EMBARGO: A CASE IN POINT

One of the major objectives of a grain reserve is market stabilization. The reserve's stabilizing ability can be tested by examining its ability to deal with unexpected market developments. Perhaps the greatest source of grain market instability for the United States has been its export market, and one of the most unpredictable components of export demand has been grain trade with the Soviet Union. (See table 5.) A substantial shock to grain trade with the Soviet Union occurred January 4, 1980, when President Carter suspended delivery to the Soviet Union of any U.S. grain exceeding 8 million metric tons--an amount already committed under an earlier grain trade agreement which went into effect on October 1, 1976.

At the time the President ordered the suspension of grain sales to the Soviet Union, it had contracts for delivery of U.S. grain from private exporters totalling 21.8 million metric tons--6.7 million tons of wheat and 15.1 million tons of corn--of which 5.5 million metric tons had already been shipped. 1/ In accordance with article II of the 5-year U.S.-U.S.S.R. Grain Agreement, the U.S.S.R. could import only 2.5 million tons of additional grain. As a result, the suspension of sales reduced U.S. exports to the Soviet Union by at least 13.8 million metric tons. In this section, an analysis is made of the impact of the Soviet grain embargo on the farmer-owned reserve and the reserve's ability to deal with such a massive shock.

To examine the implications of this change, suppose the reductions of wheat and corn exports occur in equal proportions. Thus, the actual exports of wheat during the 1980 fiscal year would be the 6.7 million metric tons originally contracted, reduced by the proportion of original contracts that cannot be shipped under the embargo, 13.8/21.8; i.e., 4.24 = 6.7 x (13.8/21.8). A similar assumption for corn would suggest corn export reductions due to the embargo of 9.55 million metric tons; i.e., 9.55 = 15.1 x (13.8/21.8). Equivalently, this amounts to reductions of 154 million bushels and 376 million bushels for wheat and corn exports, respectively. Assuming these reductions would be spread evenly over the three quarters of the fiscal or trade year

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1/D.E. Hathaway, statement made to the Subcommittee on International Finance, Committee on Banking, Housing and Urban Affairs, U.S. Senate, Jan. 22, 1980.

TABLE 5

U.S. AND SOVIET GRAIN PRODUCTION AND TRADE

Marketing Year	U.S. Prod.	Total U.S. Exports	U.S. Exports to USSR	USSR Prod.	Total USSR Imports a/	U.S. Avg. Annual Price b/
	-------------	-----	million metric tons	-----	-------------	—$ bu.—
1970/71						
Wheat	36.8	19.9	0	99.7	0.5	1.33
Coarse Grains	145.2	18.9	0	76.9	0.3	1.33
1971/72						
Wheat	44.1	16.8	0	98.8	3.5	1.34
Coarse Grains	188.3	24.5	2.9	72.6	4.3	1.08
1972/73						
Wheat	42.1	31.8	9.5	86.0	15.6	1.76
Coarse Grains	181.3	39.1	4.2	72.5	6.9	1.57
1973/74						
Wheat	46.6	32.9	2.7	109.8	4.5	3.95
Coarse Grains	186.1	49.4	5.2	101.0	6.4	2.55
1974/75						
Wheat	48.4	27.4	1.0	83.9	2.5	4.09
Coarse Grains	150.4	35.7	1.3	99.7	22.7	3.03
1975/76						
Wheat	57.8	31.7	4.0	66.2	10.1	3.56
Coarse Grains	184.7	50.0	9.9	65.8	15.6	2.54
1976/77						
Wheat	58.2	25.5	2.9	96.9	4.6	2.73
Coarse Grains	193.5	50.6	4.5	115.0	5.7	2.15
1977/78						
Wheat	55.4	30.6	3.3	92.2	6.7	2.33
Coarse Grains	203.4	56.3	9.2	92.6	11.7	2.02
1978/79						
Wheat	48.9	32.5	2.9	120.8	5.1	2.94
Coarse Grains	217.4	60.2	8.3	105.3	10.0	2.20
1979/80 c/						
Wheat	58.3	36.1	(d)	86.0	9.8	3.60-3.90
Coarse Grains	233.9	62.7	(d)	84.0	14.9	2.25-2.45

SOURCE: Statement by Honorable Bob Bergland, Secretary of Agriculture, to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, January 22, 1980.

a/July-June year.

b/Coarse grain price is for corn only.

c/Forecast.

d/The U.S.S.R. may purchase up to 8 million metric tons of U.S. grain in the fourth agreement year (Oct. 1979 - Sept. 1980).

following President Carter's announcement, the quarterly reductions in exports are 52 million bushels for wheat and 125 million bushels for corn.

The effects of such an unexpected shock on the U.S. grain economy can be analyzed using the econometric model in table 1. Although actual data was not yet available for the embargo period at the time of this study, the Chase Econometric Associates, Inc., forecasts for the variables in the econometric model can be used as a basis to evaluate departures due to the embargo. However, because these forecasts tend to be more in error for longer forecast horizons, only data from the first quarter of the embargo is analyzed below. The first quarter of 1980 was history at the time of this study, even though the data were not yet available in published form. Thus, the forecast data should be fairly accurate and no unexpected large changes should occur to invalidate the analysis presented here. The April 1980 Chase forecast was used for the analysis.

The estimated effects of the embargo on grain market prices and quantities are presented in table 6. Again, as in table 3, these effects were developed by fitting the model in table 1 to actual (forecast) data. That is, disturbances were determined for each equation so that the model perfectly fits 1980 I data. Then these disturbances were used in estimating the effects of altering policy. Impacts on the livestock market of these changes are not included since the short-run effects are negligible. Substantial effects may be realized by the livestock industry over time, but these effects begin to occur only after livestock supply has sufficient time to respond to new grain prices. These latter effects could also be estimated using the model in table 1 but only with considerably more computational expense and estimation error (because less is known about future prices and quantities). 1/

The estimates in table 6 compare the effects of the Russian embargo with and without the farmer-owned reserve program in effect in the United States. Thus, four policy alternatives can be considered, depending on imposition of the embargo and operation of the reserve. All of the

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1/Even forecasts from the major econometric firms such as Chase Econometrics Associates, Inc., generally entail 10- to 20-percent errors over forecast horizons long enough to capture the major part of livestock industry response. Errors of this magnitude in price and quantity estimates can lead to much greater relative errors in estimates of real income effects.

TABLE 6

GRAIN MARKET IMPACTS OF THE SOVIET GRAIN EMBARGO, 1980 I

Case	Price	Disappearance	Private Stocks	Exports	FOR a/
	($/bu.)	——million bushels——			
WHEAT					
Actual: with embargo and FOR	3.71	209	886	390	230
Estimated: no embargo, with FOR					
-FOR cleared at release levels b/	3.29	214	913	442	145
-FOR cleared at observed prices	3.71	209	885	442	178
-FOR cleared at call levels	4.11	205	859	442	209
Estimated: with embargo, no FOR	6.00	186	917	381	0
Estimated: no embargo, no FOR	6.53	182	880	422	0

TABLE 6
(Continued)

CORN					
Actual:					
with embargo and FOR	2.38	1411	3874	807	586
Estimated:					
no embargo, with FOR					
-FOR cleared at release levels	2.50	1415	3852	932	480
-FOR cleared at observed prices b/	2.38	1418	3852	932	455
-FOR cleared at call levels	2.80	1408	3796	930	544
Estimated:					
with embargo, no FOR	3.70	1388	3927	777	0
Estimated:					
no embargo, no FOR	4.07	1381	3855	857	0

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a/Farmer-owned reserve.

b/These scenarios are less reasonable according to arguments in the text.

effects of the four alternatives can be estimated using table 1, except the case with no embargo where the farmer-owned reserve is in operation. To deal with the latter case requires information about how high prices must rise before the farmer-owned reserve enters market channels. The mechanics of the program suggest that the reserve would not be sold until prices reach at least the release levels and that they would be cleared before prices rise above call levels. But whether most of the reserve stocks will be sold near release levels or near call levels is not clear.

Since the program imposes only a single lower bound on price (i.e., the loan rate), the theoretical nature of behavior in cases of low price is unambiguous. However, the dual nature of upper price bounds makes the theoretical behavior of the market somewhat ambiguous for high price cases. Thus far, only limited observation of the program has been possible for high price cases. Corn prices reached the release price only for a little over a month on two occasions in the summer and fall of 1979. Wheat prices rose to the release price for the first time in May of 1979. In each case, storage payments were not discontinued until sometime after release status was entered. In the case of corn, no quarterly observations were yet available where the release provisions of the program were in operation. Of course, in neither case were call levels reached, so no data pertaining even partially to that case has been generated.

Because the operation of the farmer-owned reserve is somewhat unclear at high prices, the associated results for the estimated case with the farmer-owned reserve in table 6 are developed under three scenarios. The first assumes that if the embargo had not been imposed, the reserves would have been sold at release levels. This was clearly not the case for wheat for the case where the embargo was imposed (which is represented by actual data). Nevertheless, it represents a lower bound on the set of prices where reserves would be sold. The second scenario assumes that reserves would be sold at the same price in the event of no embargo as with the embargo or, more specifically, at the actual prices which occurred under the embargo case. This is probably inappropriate for corn since the quarterly price was actually below the release price. This case seems reasonable for wheat, however. The third scenario assumes that reserves would not have been sold until prices reached call levels if the embargo had not been imposed. This case would have been likely if higher prices would have been anticipated by farmers through a rising market as Soviet exports imposed increasing upward price pressures.

The release and call levels used for this policy case are the ones that existed prior to the embargo. This seems to be the most likely policy alternative because the higher loan rates, release levels, and call levels were instituted in 1980 as a measure to ease the adverse effects of the embargo on producers. 1/

Finally, before proceeding with the analysis, it should be noted that actual data on levels of farmer-owned reserves were not yet available during 1980 at the time of this study, so the latest data available was used.

The results in table 6 imply that the embargo may have had significant effects on U.S. grain markets under the farmer-owned reserve program. 2/ Farmer-owned reserves may have been falling as much as 52 million bushels per quarter for wheat and 106 million bushels per quarter for corn compared with the case with no embargo (ignoring the less reasonable cases indicated above). If this rate had persisted, the reserves would have been exhausted in four to six quarters. Of course, however, the unusually large Soviet demand may not have persisted beyond contracts already existing for the trade year ending with 1980 III. Furthermore, if reserves were held until call levels were reached, then the reserve would have dropped only 21 million bushels per quarter for

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1/According to a statement by Secretary Bob Bergland to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, Jan. 22, 1980, provisions of the farm program designed to reduce adverse effects of the embargo on producers included raising loan rates from $2.35 to $2.50 for wheat and from $2.00 to $2.10 for corn. Furthermore, the release price for wheat was raised from 140 to 150 percent of loan rate and the call price was raised from 175 to 185 percent of loan rate. For corn, the release price continued to be 125 percent of loan rate, but the call level was raised from 140 to 145 percent of loan rate.

2/While the results in table 6 imply rather high prices in the case of no farmer-owned reserve, one must bear in mind that total stocks are substantially lower for those cases (by about the size of the farmer-owned reserve since other private stocks are near the same). Furthermore, exports to the Soviet Union even under the embargo were at about the same level as in the 1973-74 crop season (table 5). Wheat prices in excess of $6.00 may well be plausible where Soviet exports are triple the 1973-74 level, which table 6 indicates they would have been in absence of the embargo.

wheat and 42 million bushels per quarter for corn so the period of adequacy for reserves would have been much longer. On the other hand, one must bear in mind that as reserves decline, private stock demands increase (table 1). This increased demand could have caused the extent of reserve depletion in future quarters to increase as prices were bid up in the absence of an embargo.

Turning to the effects on prices and quantities, the price could have been as much as $0.40 per bushel higher for wheat and $0.52 per bushel higher for corn if the embargo had not occurred under the farmer-owned reserve. On the other hand, if the farmer-owned reserve had not been in operation, then the effect of the embargo would have been a $0.53 per bushel price decline for wheat and a $0.37 per bushel price decline for corn. These price differentials are associated with modest changes in disappearance (although disappearance appears to depend substantially on whether the farmer-owned reserve is implemented). However, private stocks tend to be more responsive in absence of a farmer-owned reserve. The change in stocks for wheat of 37 million bushels in absence of a farmer-owned reserve is larger than for any of the three scenarios with a farmer-owned reserve. For corn, the change in stocks without a farmer-owned reserve is higher than the estimates for the case of a farmer-owned reserve except when reserves are held until prices approach call levels. This responsiveness of stocks is required to accommodate the more responsive nature of exports at the higher prices resulting in absence of an embargo.

Again, the magnitude of benefits associated with these differentials cannot be evaluated directly from price and quantity data because the extent of cost savings or possibilities for substitution are not evident. Quantitative information can be derived using the economic surplus concepts discussed earlier using the estimates in table 1. These results, which correspond to the price and quantity differentials in table 6, are reported in table 7. While producers would not experience a direct effect on economic welfare in 1980 I according to the model in table 1 (because production is only realized in quarters III and IV), an estimate of the average quarterly effect may be obtained as the change in revenue on one-quarter of the crop resulting from the change in price. These figures are reported in table 7 as a standard of comparison for the welfare effects on other market groups.

The estimates in table 7 confirm that effects on economic welfare tend to be higher in absence of the farmer-owned reserve. The gain for wheat consumers from lower prices under the embargo is more than three times

TABLE 7

REAL INCOME EFFECTS OF THE SOVIET GRAIN EMBARGO

WITH AND WITHOUT THE FARMER-OWNED RESERVE (FOR), 1980 I

Case	Market Groups			
	Consumers	Stockholders	Foreign Concerns	Producers a/
WHEAT	million dollars			
No FOR	+66.4	+3.4	+2.7	-283.8
FOR cleared at release level b/	-15.3	-1.5	-0.3	+224.9
FOR cleared at observed prices	+0.3	(c)	+0.4	(c)
FOR cleared at call level	+18.6	+1.6	+1.2	-214.2
CORN				
No FOR	+23.2	+10.0	+3.8	-718.1
FOR cleared at release level	+7.4	+2.0	+11.4	-232.9
FOR cleared at observed price b/	+0.8	(c)	+0.6	(c)
FOR cleared at call level	+24.3	+ 7.6	+2.5	-815.2

a/Estimated on a quarterly basis by allocating the annual impacts equally among quarters assuming the annual differential impact on price is the same as estimated for 1980 I.
b/These scenarios are less reasonable according to arguments in the text.
c/Negligible effects.

greater with no farmer-owned reserve than the scenario with the largest change under a functioning farmer-owned reserve. For wheat stockholders and foreign concerns, the gain is a little more than twice. These gains, however, are more than offset by producer losses which are also higher in absence of a farmer-owned reserve. The net effect of the farmer-owned reserve on wheat market groups as a whole is a reduction in the loss in economic welfare or real income associated with imposition of the embargo in the amount of at least $18.5 million per quarter. Furthermore, the farmer-owned reserve seems to reduce the vulnerability of every individual market group to unexpected developments in the export market. In this respect, one of the apparent objectives of the program is met for wheat.

These results, however, must also be evaluated in the context of results obtained in table 4. Results there imply that real income is reduced on average for many market groups and for all groups taken together. Thus, the lower vulnerability to unexpected market developments with the farmer-owned reserve may be due to the fact that there is less to lose. One way of evaluating these possibilities is to compare the magnitude of the directional effect in table 4 with the degree of vulnerability to unexpected developments suggested by table 6. With this in mind, the net reduction in loss per quarter of $18.5 million estimated above is very small compared with the directional effects estimated in table 4. Thus, unless the likely magnitude of unanticipated changes in the wheat market is larger than for the Soviet embargo (which is doubtful), then the reduced vulnerability is not sufficient to override implications of the analysis of table 4. One may further note that this is true with respect to every individual market group.

Turning to the case of corn, a similar result is found in comparing the case of no farmer-owned reserve with the case of a farmer-owned reserve where reserves are cleared at release levels. If reserves are cleared at call levels, however, then the comparison is reversed for consumers and producers. Thus, for corn, consumers generally gain more and producers lose more than if the embargo were imposed in absence of a farmer-owned reserve. This result suggests that the call level for corn is too high to cause the farmer-owned reserve to absorb shocks in the corn market. Again, however, the net effect is negative. Also, these effects are secondary to those considered in table 4. Thus, while the objectives of the farmer-owned reserve associated with meeting unexpected situations seem to be met to some extent, the value of meeting these objectives for the market participants is less than the value of giving up the reserve from other respects.

The above analysis suffers from several important simplifications, but the major simplifications lead to biasing the effects upward rather than downward. For example, the change in CCC activity which accompanied the embargo has not been considered. As part of the embargo policy, Secretary Bergland announced that CCC would assume the contractual obligations for grain shipments to the Soviet Union that would be prohibited by the embargo. 1/ If the same amount of grain were taken out of commercial channels as would otherwise have gone to the Soviet Union, then the effects would be approximately the same. For example, the model in table 1 indicates that increased CCC ownership of wheat has a small effect on the commercial market whereas no effect could be found for CCC corn ownership in the corn market. Furthermore, unlike corn, the wheat would have less potential for reentering the commercial market since it was to be used in support of foreign food assistance programs. Thus, these accompanying policies could negate impacts of the embargo on U.S. commercial grain markets.

The above discussion also essentially avoids the issue of response by other major grain exporters; that is, it is not known to what extent Australia, Canada, and Argentina also blocked grain sales to the Soviet Union. These three countries are large wheat exporters to the Soviet Union but export relatively little feed grain. At the extreme, if the U.S.S.R. is able to meet its demands by buying additional grain (wheat) from these three nations, the impact on U.S. wheat prices would be minimal in the United States, since it would export more to those markets (excluding the Soviet Union) where the above three countries now ship. In a sense there would be substitution among markets, although it may not be perfect. However, if the other exporters did not ship to the Soviet Union (even though there would be some illegal shipments to the Soviet Union from importers of grain from the United States, Canada, Australia, and Argentina), the impact on U.S. grain markets would be much greater. However, in this case, the other exporters also experience substantial market impacts.

One might further note in the context of this discussion that the impact on U.S. feed grain prices likely

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1/Statement by Secretary Bob Bergland to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, Jan. 22, 1980.

does not depend as critically on the reaction from other exporters as for wheat. This is because the United States is by far both the world's largest feed grain exporter and the largest exporter to the U.S.S.R. (See table 5.) Thus, in the absence of other offsetting policy changes, the United States' livestock sector could be expected to eventually benefit from the embargo due to cheaper internal feed grain prices. This effect could not be greatly offset by sales expansion to the Soviet Union by other exporters because of the U.S. dominance of that market. Again, however, if this is a short-lived development, the false price signals for livestock industry expansion could lead to ultimate losses for the livestock industry as well.

Finally, it is worthwhile to consider the combination of circumstances where CCC assumes contractual obligations at the same time other exporters fill Soviet demands for grain. In this case, substantial amounts of U.S. grain would be leaving commercial channels and, at the same time, demand by importers other than the U.S.S.R. could be unfilled because of other exporters shipping to Soviet markets instead. Thus, the same overall commercial demand for grains could exist as without the embargo as in the case where the embargo is not imposed while a smaller supply of commercial grain could exist to fill it. In this case, the change in CCC policy together with the embargo could actually have strengthened U.S. and world grain markets, in which case U.S. grain consumers would be losers and U.S. grain producers would be gainers. Of course, if these are the realistic assumptions, then the analysis in tables 6 and 7 should be revised and could have as much as roughly opposite implications.

In each case, however, the estimates together with additional considerations imply that benefits from the reserve for encountering stocks in the wheat market are rather small compared with other considerations. These conclusions are apparently consistent with the confidence shown in the farmer-owned reserve policy. That is, if the reserve policy were viewed as capable of handling large shocks in the grain market, then such major revisions in the reserve policy (loan rates, release levels, call levels, storage payments, interest payments, and accompanying CCC policy) would not be required with such developments as the Russian grain embargo.

SECTION 12

CONCLUSIONS REGARDING EFFECTIVENESS OF THE FARMER-OWNED RESERVE

The goal of U.S. agricultural grain stock policy has been to ensure against uncertainties of weather and trade policies of foreign countries that could prevent attainment of the following objectives of U.S. agricultural policy:

1. Maintaining the productive base by stabilizing agricultural prices and supporting farm income.

2. Protecting domestic consumers by providing adequate supplies at reasonable prices.

3. Ensuring availability of exports for commercial and humanitarian needs and to improve U.S. trade balances.

4. Holding down long-run Government costs.

5. Combating inflation. 1/

The evidence of this study on the farmer-owned reserve program's ability to meet these objectives is mixed at best.

The program seems to have fostered greater stability of prices and incomes than would have existed in absence of a farmer-owned reserve (table 3). Also, the reserve seems to have a capability of reducing short-run vulnerability to unexpected developments in the world market (table 7). However, these gains in stability have come at considerable expense in terms of average farm income for grain producers (table 4). Furthermore, the econometric results show that short-run stability is not highly valued by producers; risk response did not prove to be important. 2/ Livestock producers, on the other hand, can be major benefactors from both lower grain prices after reserve accumulation (table 2) and greater market stability (table 3). However,

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1/Taken from Harold Jamison and Roy Cozart, "Draft Impact Analysis," USDA-ASCS, Dec. 10, 1979.

2/The results, however, show that long-run stability could have considerable impact because of greater planning ability and the associated economic efficiency in investment.

the livestock industry benefits do not appear to outweigh the costs imposed on grain producers or meat consumers. Thus, the first objective appears to be met in part but the costs of not meeting the second part of the objective may outweigh the benefits of meeting the first part of the objective.

Turning to the second objective, it appears that consumer interests have been well protected in the grain markets but major losses have been suffered in the meat market as a result of the policy. However, the bulk of loss in the meat market is due to problems of adjustment due to false price signals in the livestock industry. These losses should gradually turn into gains as the livestock industry is able to adjust. In fact, the results in table 4 indicate that these gains were beginning to be realized in 1979 II. Again, however, one must note that the net consumer gains resulting from the policy are more than offset by producer losses.

For the third objective, there is no evidence that suggests lack of availability for exports under the program. In fact, because of reduced year-to-year private stock demand and reduced grain prices, the results suggest improved export availability. By the same token, however, the reduced grain prices lead to deteriorated U.S. trade balances; prices are eventually lower under the program and, due to world market saturation at low prices, export quantities are only negligibly higher (table 2). Again, the evidence is mixed; the ultimate evaluation of results relative to the third objective depends on the extent to which humanitarian needs for food at low prices are valued in U.S. policy formulation. Evidently, lower export prices are attained at the expense of U.S. producers and U.S. trade balance deterioration. Furthermore, from the standpoint of maintaining an emergency food reserve for humanitarian reasons, the size of the farmer-owned reserve is deceivingly large; estimates show that over 80 percent of the wheat reserve and over 50 percent of the corn reserve are serving the purpose of commercial reserves for the farmers who actually control sales decisions.

For objective four, the evidence is clearly and strongly negative. The coefficient for response of private stock levels to farmer-owned reserve levels in table 1 is very large relative to the coefficient for CCC or Government-owned stocks. These results imply that a much larger Government-related reserve is required to reach the same level of insurance of adequate emergency supplies under the farmer-owned reserve than with CCC ownership. Storage costs paid by the Government in the case of wheat are more than five times greater with the farmer-owned reserve. In fact, after considering the interactions with extended markets, the difference in Government costs are even greater. Results suggest that farmer-owned reserves are viewed as close substitutes for private market stocks and, as a result, the Government can suffer the burden of paying storage costs which would normally be assumed by private market concerns.

Finally, the evidence on inflation is also somewhat mixed. 1/ Grain prices are ultimately lower with the reserve program but meat prices are increased substantially in the intermediate run (up to six quarters). Examining the results in table 4 suggests that consumers of food are better off over all. One must also consider the effect on U.S. trade balances, however. As trade balances deteriorate, exchange rates turn against the United States so that foreign goods become more expensive. Thus, foreign goods may become relatively more expensive for consumers. But these latter effects are probably secondary.

The stated objectives of the reserve program are conflicting. Prices cannot be simultaneously lowered for consumers and increased for producers without increasing Government costs. Thus, it is not surprising that the evidence is mixed regarding attainment of program objectives. An ultimate evaluation of the reserve program depends on the importance of each objective. Such issues can only be decided by the lawmakers responsible for policy formulation.

However, one interesting piece of evidence can be compiled by considering market participants' evaluation of the effects. That is, suppose for each group which gains under the reserve policy that one can determine how much they would be willing to pay, at most, to have the reserve policy. Then suppose for each group which loses under the reserve policy that one can determine the least amount of transfer payment that would cause them to prefer the reserve policy if accompanied by the transfer payments. With this information, one can hypothetically consider financing the transfer payments from the gains of those groups for whom economic welfare is improved. If this is possible, then some system of transfer payments exists so that everyone is better off with the reserve policy. If not, then some system of transfer payments exists so that everyone is better off without

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1/While this type of objective may not make sense for grain stock policy in the context of general theories of inflation, it makes sense if interpreted as an objective of avoiding food price increases. This is the sense in which the objective is evaluated here.

the reserve policy. The estimates in table 4 are, in fact, estimates of these gains and losses and suggest that those who were worse off in the first 2 years of the farmer-owned reserve program could easily have financed necessary transfers to those who gained so that everyone would have been better off without the program.

In reaching these conclusions, however, one must bear in mind that the 2-year period analyzed here was one of relative surplus; expenses are generally incurred in accumulating Government reserves in surplus years. One should also consider the possible benefits of having accumulated such a reserve if a period of shortage were then to ensue. The reserve could be more valuable than current prices during surplus years would suggest, plus it may have the effect of holding prices down substantially on all other grain transacted in shortage periods.

To investigate the possible extent of such effects, one can consider the various cases of no embargo with a farmer-owned reserve program in table 6. The results here imply that drawing down farmer-owned reserve stocks by an extra 31 million bushels per quarter leads to a $0.40 per bushel reduction in wheat price and that a reserve reduction of 64 million bushels reduces wheat price by $0.72 per bushel. In the case of corn, an 89 million bushel reduction in the farmer-owned reserve reduces corn price by $0.42 per bushel and a 64 million bushel decrease reduces corn price by $0.30 per bushel. Thus, price reactions are fairly substantial with total elasticities on the order of unity.

But one must bear in mind that such price reductions involve to a large extent simply transfers from producers to consumers so that the associated net welfare gains are less than the change in value of production. With this in mind, it appears that the net costs of accumulating the farmer-owned reserve may or may not be recovered if a shortage were to develop. Thus, some potential for net gains from the farmer-owned reserve may still be possible even though net losses over the first 2 years have apparently been higher.

SECTION 13

IMPLICATIONS FOR NEW AGRICULTURAL POLICY FORMULATION

The results of this study have important implications for the design of future agricultural policy. First, since market stocks are so much more responsive to farmer-owned reserves than Government-owned reserves, results show that any effort to hold an emergency food reserve should be tied to CCC ownership rather than farmer ownership. 1/ Otherwise, the Government bears the cost of some stocks held for market purposes and the extent of this cost can be substantially greater than otherwise.

Second, the results of this study emphasize that costs of adjustment to new policies can be substantial. Initial price adjustments that differ from long-run equilibrium levels cause false price signals for producers. These false price signals can then cause substantial maladjustment, particularly in the livestock industry because of long lags in production.

The results in table 2 suggest that adjustments in the livestock sector were far from complete even after eight quarters of the new program. During this long period of adjustment, the 1977 changes in policy led to poor investment decisions which contributed to serious economic inefficiency. In view of these results, the recent practice of changing agricultural policy substantially every 4 years seems to impose unnecessary costs on the agricultural sector. With policy changing every 4 years, the livestock industry can be continually in a state of trying to adjust to new policies because of its inability to adjust quickly.

Furthermore, these costs are over and above any risk imposed on the agricultural sector because of uncertainties about what future policies may be. Economic inefficiencies resulting from unrealized anticipations about what new programs may exceed those considered in table 4. The inefficiencies in table 4 relate simply to false investment anticipations about what the effects of a program on price are likely to be <u>given the provisions of the program</u>. These considerations point to the importance of designing policy which is self-adjusting (so changes can be anticipated by

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1/Or, again alternatively, the mechanism governing the farmer-owned reserve should be modified so that other private stocks are less responsive to farmer-owned reserves as they were to CCC stocks in earlier years.

producers) and which causes only smooth, orderly changes in price (so large changes in investment are not induced which cause years of similarly large oscillatory adjustments in related markets).

A further issue along this line relates to the choices of specific levels of loan rates, release levels, call levels, and accompanying set-aside requirements. For corn, release levels have been high enough that they have been rarely reached. For both wheat and corn, the loan rates were high enough that farmer-owned reserves accumulated very rapidly during the 1977 and 1978 crop years. If the unusually large Soviet grain demand had not occurred in the 1979 crop year (and had not been offset by other policies after the embargo), grain prices could have been low again and farmer-owned reserves could have become unmanageably large. Furthermore, these developments were occurring while set-aside requirements were being imposed for the 1978 and 1979 crops.

In fact, the evidence suggests that once the farmer-owned reserves approached goal levels, the policy became essentially one of choosing set-aside controls to avoid further reserve accumulation (excluding the embargo period). As a result, one of the most important policy controls--the set-aside requirement--was determined annually so that producers could not anticipate policy effects even 1 year in advance.

Furthermore, major developments led to more than one major revision in policy during the 4-year period. A depressed grain market led to the Emergency Agricultural Credit Adjustment Act of 1978, which was soon accompanied by higher loan rates, release levels, and call levels for wheat. And, of course, the Soviet embargo was accompanied by major revisions described in section 11. Each of these major revisions was apparently necessary to correct inadequacies in the program. Thus, producers not only suffered from an inability to anticipate set-aside requirements more than a year in advance but also from inability to anticipate other major policy changes during the policy period since 1977. When a grain farmer is considering investments in machinery, etc., but does not know how much grain he will be allowed to plant the following year, he is likely to make a poor decision. As evidenced by the results in table 2, the investment inefficiency in the livestock sector can be even greater because of the long term required for herd expansion and subsequent production of feeder animals.

POSSIBILITIES FOR IMPROVED ADMINISTRATION OF EXISTING CONTROLS

In view of these considerations, strong possibilities appear to exist for improving economic efficiency with agricultural policy design. But what characteristics should agricultural policy have to promote improved economic efficiency? First, the policy should not involve annual all-or-nothing types of decisions about whether or not set-asides should be imposed. More orderly changes, such as the degree to which a control should be applied, would be more appropriate. For example, the policy since 1977 has involved setting a particular level for the loan rate and then, when it appears to be too far out of line, a substantial revision is made.

Experience suggests that this piecemeal approach will always be necessary when specific levels of, say, loan rates are determined only after existing levels appear too far out of line. For example, simulation studies (not reported) with the model in table 1 have indicated that the loan rates were relatively high in 1977 and 1978 but that, after sufficient inflation, the release levels would have become too low. As a result, the policy acted more like a simple price support in early years, in which case economic welfare analysis clearly implies a net loss for society as a whole. On the other hand, after sufficient inflation, the release level would act as a price ceiling in absence of set-asides at least until reserves were depleted. Again, economic welfare analysis clearly implies a net loss for society as a whole.

One would expect that loan rates would eventually be raised to avoid further depletion of reserves in this case. But as a result of this type of policy approach, the program can become a destabilizing influence or, at best, promote economic inefficiency by artificially holding prices up immediately after loan rate revisions and then artificially holding prices down after inflation and just before new revisions. A better approach would be to change loan rates more frequently in smaller amounts in accordance with observed and anticipated changes in equilibrium price levels. Then prices could be stabilized near equilibrium or efficient price levels rather than near distorted price levels.

Moreover, an even better approach would be to specify in advance how the specific controls of the program (loan rates, etc.) will be changed in response to market conditions. In this way, farmers can better anticipate such changes through their own assessments of future market conditions. Thus, better investment decisions should be possible than when farmers are left to guess about future policy control levels. As evidenced by the results in tables 2 and 4, this approach could lead to substantial improvements in economic welfare for society as a whole.

When considering the observed conditions which influence revisions of controls, the most important ones include farmer income levels, inflation of food prices, the size of Government-related stocks, and Government costs. The loan rates supposedly avoid low farm incomes, while the release and call levels avoid rapid food price inflation. But acceptable levels of farm income and consumer prices change with inflation. So, perhaps, loan rates and release and call levels should be keyed to inflation so that changes in their levels can be anticipated by farmers in planning decisions.

Set-asides are supposedly set to avoid overaccumulation of reserves which lead to high Government costs. So, perhaps the level of set-aside requirements should be keyed to the level of accumulated reserves--in an explicit published way which allows farmer anticipation. Furthermore, to avoid the uncertainty that could occur when reserves are near a level where set-asides would be imposed or not, perhaps the reserve levels of any set-aside requirements should vary continuously. For example, a 1-percent set-aside could be required for every 20 million bushels of wheat in Government reserves. Thus, farmers could anticipate the set-aside requirement often within 1 or 2 percent and therefore face much less uncertainty in planning than when, for instance, either a 20-percent requirement or no requirement is imposed.

Set-asides can be used to avoid overaccumulation of reserves, but price incentives are generally necessary to avoid reserve depletion. Thus, loan rates, for example, must necessarily be increased when reserves become low. But rather than making these revisions in a piecemeal manner which is hard to anticipate, the loan rate could also be explicitly tied to the level of Government reserves as well as to inflation. For example, the loan rate could be increased $0.01 per bushel for every 3 million bushels the Government reserve is below some target level. If farmers could anticipate this adjustment process rather than speculate about it in making investment decisions, agricultural production should attain greater economic efficiency with less risk. In fact, with more efficient investment in the agricultural sector, lower prices may lead to the same levels of income.

IMPROVED POLICY CONTROLS BASED ON GOVERNMENT OWNERSHIP

Another consideration relates to the "all or nothing" applicability of loan rates and release or call levels. A loan rate theoretically plays no role unless price falls to the loan rate; then it theoretically acts as a controlled price below which price levels do not fall regardless of how much grain goes under Government loan at that price. Similar arguments apply to release and call levels for grain sales, although the degree of enforcement is less. In this context, Government policy may offer no benefits when prices are near normal levels and costs of providing some stabilizing influence would be very cheap. On the other hand, a very high level of benefits is provided in a very extreme situation in which the costs may be much greater than benefits. In fact, it is this type of situation that has sometimes caused programs to require unexpected modification.

Unexpected market developments may lead to a large increase in reserve levels; consequently, Government costs can get unbearably high. One way to ease this burden interseasonally is to make the price-control levels explicitly dependent on stock levels, as suggested above. But another way to ease this burden interseasonally is to operate the controls according to a prespecified scale. In other words, rather than the Government offering to take all grain at a loan rate, it could offer to buy, say, 1 million bushels of grain for every $0.01 per bushel the price is below a target level. Similarly, the Government could sell 1 million bushels from stocks for every $0.01 per bushel the price is above the target price. If these transactions were made at market prices, then it would make no difference which farmer's grain was actually purchased by the Government.

In this way, some stabilizing influence is provided when prices are near equilibrium and stability comes at very low cost. On the other hand, the Government does not promise to stick to hard and fast price limits that may have to be revised when Government costs become excessive. Furthermore, with this type of policy, the stabilizing influence can be provided throughout a marketing season. For example, as the price starts to move up, the Government could begin to sell stocks to ease price increases; as price starts downward, the Government could buy stocks to ease price declines. Thus, the announced policy of, for example, 1-million-bushel transactions for a $0.01 change in price would be an equilibrium relationship that could be applied continuously in determining Government stock transactions. In practice, of course, the market price used in governing these transactions should be some type of moving average price so that transactions are not based on day-to-day random market fluctuations but perhaps on week-to-week or month-to-month fluctuations. But the interval of transactions should not be too long so that prices get too far out of line or cause too much price unsettlement when transactions finally occur.

Finally, to make this stabilization policy operational and self-adjusting interseasonally, a rule should be specified for modification of target price from period to period. One way to make this rule responsive to Government cost considerations is to make it dependent on the level of Government stocks relative to some Government stock goal. That is, suppose the Government determines a long-term stock goal of 400 million bushels of wheat based on a variety of considerations. Then the target price could be increased for each succeeding year by, say, $0.01 for every 3 million bushels the Government wheat stock is below 400 million bushels; similarly, the target price could be lowered $0.01 for every 3 million bushels the Government stock of wheat is above 400 million bushels. This rule for target price modification would automatically adjust to changing inflation rates since high producer costs would cause, in turn, less supply, higher price, lower Government stocks, and finally higher target price.

If this rule for buying and selling Government stocks were announced and known well in advance (e.g., years in advance), then decisionmakers could assess the effects of Government policy in making their investment decisions based on market forces. There would be no policy uncertainty due to decisionmakers guessing with little or no advance notice what the Government would do next. They would simply have to assess a market situation and then consider the Government actions specified for that situation. Similarly, the Government would not be introducing additional uncertainty into the market in the way that specific control levels are modified, since they would be determined on the basis of market phenomena--an uncertainty that farmers already face. Furthermore, the self-adjusting controls would be acting to reduce the market effects of the existing uncertainty.

IMPROVED POLICY CONTROLS BASED ON FARMER OWNERSHIP

Government ownership of grain reserves has come to be viewed with a great deal of skepticism because of the large amount of power it concentrates in the hands of a few individuals in making Government buy/sell decisions. Presumably, the proposed policy discussed above avoids these problems because the Government buy/sell decisions become mechanically controlled by the initial terms of the policy. Nevertheless, for the case where Government ownership is simply viewed as politically infeasible, it is desirable to consider some alterations in farmer-owned reserve controls which could make it take on some of the smooth self-adjusting characteristics which are important in avoiding economic inefficiency.

First of all, if the farmer-owned reserve operates with release/call levels, decisionmakers will be faced with uncertainty regarding how the market will behave when prices draw near these levels. Rather than operating the program with cut-off points where at one price level farmers get a full storage subsidy and at the next slightly higher price they get no subsidy, the subsidies could be offered on a partial and sliding basis. For example, the Government could pay farmers a storage subsidy of a target amount per bushel, say $0.25 a bushel, plus 10 percent of the difference between a target price and the current price. The latter term would be positive and encourage more storage when current price is low and would be negative encouraging less storage when current price is high. When current price gets very high (e.g., $2.50 a bushel higher than the target price in this case), the storage subsidy would be completely phased out but it would be phased out in a smooth orderly manner rather than in an "all or nothing" manner as with the current release levels.

In addition to this change, the "all or nothing" aspects of the loan rate and call levels could be avoided by simply making the target storage subsidy high enough to compensate for commercial capital costs in borrowing against stored grain. Then, following the general type of storage subsidy rule above, the essential effects of all three current controls (loan rate and release/call levels) could be gradually phased in and out by the single storage subsidy mechanism above as dictated by market developments. If the rules governing storage subsidies were published well in advance, then farmers should be able to better anticipate Government program effects. And if the official current market price effective in determining storage subsidies is revised frequently, say weekly or monthly, then no market discontinuities with their accompanying uncertainties should be experienced within crop years.

Finally, to avoid the need for continual unanticipated year-to-year revisions of the storage subsidy rule, the target subsidy should be specified to depend on the accumulated size of the farmer-owned reserve. For example, the new target subsidy could be determined by subtracting $0.05 per bushel for every million tons the farmer-owned reserve exceeds some goal level for the reserve size (or adding a similar amount if the farmer-owned reserve falls below this goal level). If this revision rule were known well in advance by producers, then the effects of current and expected future market developments could be taken into account in making effective investment decisions which affect future periods. Thus, the uncertainty associated with unanticipated policy changes could be avoided. Furthermore, with this type of rule, revisions would be assured so that reserves would not begin to accumulate indefinitely leading to excessive Government costs. Nor could reserves continue to be depleted over a period of many years.

The general policy outlined in this section attains much of the desirable nature of the policy outlined on pages 90 and 91 (except that Government storage costs may be higher in this case due to payment of storage costs for grain which might otherwise be held as purely private stocks). Decision-makers would not face policy uncertainty associated with guessing with little or no advance notice what the Government would do next. Again, they would simply have to assess a market situation and then consider the Government actions specified for that situation. Government would not be imposing additional uncertainty on farmers and, in fact, the policy would act to reduce the market effects of existing inherent uncertainty.

CONCLUSIONS

Only recently have economists begun to realize the potential benefits for society of controls that are determined automatically by the severity of market conditions. Both theoretical and empirical studies have been done to analyze the type of policy suggested by the results of this study; i.e., one where Government stock transactions depend continuously on the difference between market price and some target price. In each case, studies have concluded in its favor over the usual approach of loan rates, price bands, etc. 1/ Furthermore, these studies are short-run and do not account for additional benefits of longer-term investment efficiency that are suggested by this study. Thus, the case for a more orderly agricultural policy with built-in self-adjustments that can be well anticipated is strong.

1/For a theoretical study of these issues, see R.E. Just and A. Schmitz, op. cit. For empirical simulation studies, see W.W. Cochrane and Y. Danin, Reserve Stock Grain Models: The World and the United States, 1975-85, Minnesota Agr. Exp. Sta. Tech. Bulletin 305, 1976; Y. Danin, "Grain Reserves and Price Stabilization," Department of Agriculture and Applied Economics Staff Paper, pp. 75-80, University of Minnesota, Dec. 1975; and A.C. Zwart and K.D. Mielke, "Economic Implications of International Wheat Reserves," School of Agriculture, Economics, and Extension Education, Discussion Paper 1, University of Guelph, June 1976.