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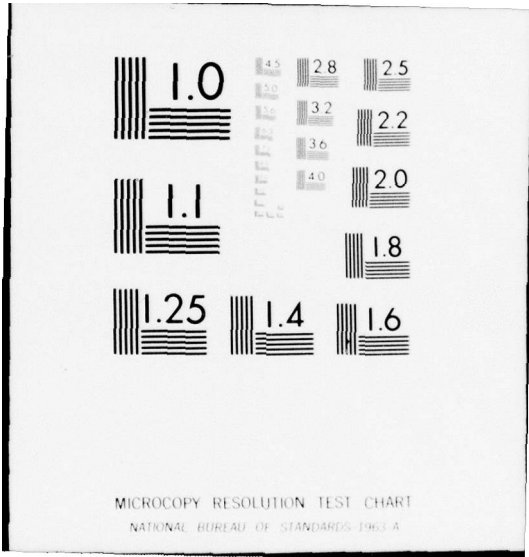
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The Economics of United States Grain Stockpiling

John Picard Stein and Rodney Topper Smith

A report prepared for

COUNCIL ON INTERNATIONAL ECONOMIC POLICY

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We examine rationales for and against U.S. Government intervention in private grain storage, analyze costs and effects of intervention, and comment on political issues and aspects of implementation. Private storage activity already appears to be highly competitive. The influences of grain stock policy on food aid policy and national diplomatic objectives constitute externalities that could justify intervention. We simulate the costs of stabilizing grain prices through subsidization reduces U.S. export earnings. Beneficiaries of subsidized price stabilization are consumers, particularly foreign consumers and meat-eaters. Price stabilization may raise or lower the mean price level; the resulting welfare effects could dominate the other effects of price stabilization. We recommend subsidization of private stocks over government managed reserves and separation of stockpiling and aid policies. We include a background discussion of forces contributing to the post 1972 rise in world grain prices. (Author)

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PREFACE

↙ This report attempts to synthesize the written discussion of grain stockpiling in the economics literature and to provide a structure for the policy discussion of grain stock issues within the U.S. Government. In addition, ~~we provide~~ some new economic analysis. While emphasizing the economic dimension of the issues, ~~we also comment on~~ how political considerations may modify conclusions based solely on economic analysis. International economic and diplomatic issues are considered from a U.S. perspective to reflect the situation of U.S. policymakers.

The report grows out of a survey of the literature, supplemented by discussions with U.S. Government officials in the White House Council on International Economic Policy (CIEP), the sponsor of this study; the Council of Economic Advisers; the Office of Management and Budget; the Departments of Agriculture, State, and the Treasury; and the Office of the Special Representative for Trade Negotiations. A computer simulation of U.S. grain stock prices, undertaken in connection with this report, will be presented in a forthcoming paper. The study was conducted during the period June through October 1975. ↗

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SUMMARY

Due to the randomness of nature, annual world grain production is inherently variable and uncertain. Taking the agricultural policies of foreign countries as given, the uncertainty in U.S. grain markets can be characterized by given degrees of variability in the schedules of domestic supply, domestic demand, and export demand. Storage moderates the effects of supply and demand fluctuations by re-allocating grain from years of relative abundance and low prices to years of relative scarcity and high prices. Storage is beneficial to both producers and consumers because it transforms grain valued at a low price in a period of relative abundance into grain valued at a high price in a period of relative scarcity.

The essential economic contribution of grain storage can be measured by its effect in stabilizing grain prices. Price stability provides supply "security" in the sense that a reduction in the amplitude of grain price fluctuations reduces the risk of high grain prices squeezing poor consumers out of the market or driving exporting countries to impose export controls.

If private storage markets are competitive, then private storers can be expected to produce the socially desirable levels of grain storage and price stability as protection for grain consumers and producers. The limited evidence available suggests that the private U.S. grain storage market is highly competitive. Private storage eliminates some price fluctuations, but some will remain. Although more stability of grain prices would be beneficial, because price stability is an economic good, the benefits of additional storage accruing directly to grain consumers and producers can be expected to be outweighed by the increased costs of storage.

However, the private market neglects nonmarket considerations arising from international diplomatic and domestic political objectives, including the provision of food aid. Increased U.S. grain stockpiling might foster U.S. diplomatic and trade objectives in the European Community, the less developed countries, the Soviet Union, Japan, and elsewhere. Increased stockpiling and price stability may reduce costly domestic friction among grain producers, consumers, and government. While government intervention in private storage markets may be designed to account for these nonmarket factors, we consider it justified only if it achieves the objectives less expensively than alternative measures and if attaining the objectives is worth the cost. However, we consider unjustified any government intervention to increase the protection of grain consumers and producers from price fluctuations, to combat inflation, or to adjust discount rates. Each of the above arguments for increased stockpiling is discussed and evaluated in the body of the report.

We focus the economics discussion of increased U.S. grain stockpiling on three parameters that appear to be essential in ultimate policy decisions and that can be analyzed by economic analysis. First, to determine the amount of increased grain stockpiling desirable for attaining nonmarket objectives policymakers should consider the resource cost of obtaining additional price stability.

Existing studies do not focus on this parameter; rather they examine the "desirable size of stock," approaching the subject in two ways. One approach mechanically calculates the probability that stockpiles of a given size would be able to offset shortfall deviations in production. This approach has also been used to calculate

stock levels resulting from government-owned stock programs with alternative stock accumulation and release prices. This approach has not provided useful estimates of the cost of additional price stability because existing studies do not focus on this parameter and because they neglect the presence of private sector storage. The second approach weighs the consumer and producer benefits and costs from stockpiling and essentially models the storage activity of profit-maximizing storers. This approach has not provided meaningful information about the costs and benefits of government intervention because the models have merely forecast storage activity by the private sector. A forthcoming Rand paper by Keeler, summarized in this report, estimates the resource cost of additional stability by adapting the second approach to examine the behavior of the private market operating under alternative storage subsidies.

Keeler's simplified and preliminary model, based on projected 1979 U.S. wheat markets, suggests that private storers can be expected to allow wheat prices to fluctuate with a long-run standard deviation of \$.72 per bushel around an assumed mean of \$2.50 per bushel. Government could expect to reduce this standard deviation by 15 percent to \$.61 per bushel with a \$.15 subsidy per bushel on carryover stocks at an expected cost of \$34 million per year. Or government could expect to reduce the standard deviation by 39 percent to \$.44 per bushel with a \$.30 per bushel subsidy at an annual cost of \$120 million. These subsidy levels are only illustrative. Policymakers must decide whether such costs are small or large relative to the nonmarket benefits that price stabilization would provide.

The second key parameter is the rate at which government-owned grain stocks would replace private stocks. This rate would depend on whether or not government stockholding were profitable in the long run. No previous studies examine this tradeoff, and we offer no estimates. Only since 1972 have U.S. Government stocks been low enough to give private storage the responsibility for holding grain stocks to arbitrage between periods of low and high prices, and a few more years may be required before the private market adjusts to this new responsibility.

However, the substitution of government for private stocks can be avoided by subsidizing the private sector to hold increased stocks rather than accumulating a government-owned stockpile. The alternative ways in which private storers may be subsidized, and the costs and benefits of each, should be explored in future research. Keeler's simulations examine what is probably not the most effective type of storage subsidy for stabilizing grain prices.

The distribution by which countries and domestic groups share the benefits of additional stabilization (ignoring that these additional benefits are expected to aggregate to less than the additional storage costs) may influence how the costs of an internationally coordinated grain stockpiling system are shared and how various domestic U.S. interests react to U.S. stockpiling. This distribution is the third parameter that, from our perspective, appears essential in policy decisions.

Although no previous analyses have treated precisely this distribution, consumer and producer benefits from additional stockpiling depend on the reduction in price variance and the change in the average level of grain prices. Economists have demonstrated that the net aggregate benefit accruing to consumers and producers is proportional to the reduction in price variance and the sum of the price responsiveness (inverse slope) of the demand and supply schedules. Also, the share of the benefits going to each supply or demand sector will be directly proportional to two

factors: the extent to which price fluctuations arise out of supply or demand uncertainty in that sector and the flatness of that sector's supply or demand schedule. Thus, most benefits are likely to accrue to foreign consumers of U.S. grain, less to U.S. producers, and least to U.S. consumers. This result assumes that most of the market uncertainty arises in the U.S. export demand schedule, with some arising in a U.S. supply schedule that is not perfectly price-unresponsive (inelastic). The benefits are likely to be greater, per unit of price variance reduced, for feed grains than for food grains, because feed grain demand and supply schedules are thought to be relatively price responsive.

Depending upon the particular type of government intervention, the stabilization program may raise or lower the average level of grain prices. Higher grain prices benefit grain producers and grain exporting countries at the expense of grain consumers and grain importing countries. The welfare effects due to a change in average price may be stronger than those due to a reduction in price variance.

We also provide in the report a background discussion of the forces contributing to the post-1972 rise in world grain prices. Evidence suggests that the price increase experienced in the world market is largely explained by the trade barriers and agricultural policies in Europe, the Soviet Union, and elsewhere that insulated grain prices in large parts of the world from the events in world grain markets.

We comment on factors related to the usefulness of U.S. grain stocks for obtaining the U.S. Government's international objectives. We question the value of stockpiling for achieving objectives involving international agricultural trade, because we believe foreign countries to be unwilling to give up protection of their domestic farm policies. Also, if the United States fails to increase its stocks, most foreign countries can increase their own stocks instead.

We comment on the effects of increased U.S. grain stockpiling on various domestic groups. These groups cannot all be satisfied simultaneously because they have conflicting goals.

We suggest that grain stock and food aid policies should be formulated independently. The administrators of the food aid budget may find it desirable to hedge their food aid requirements by stockpiling or by operating in the grain futures market. To the extent possible, food aid policy should be formulated and announced before food aid demands arise, so as to assist the private market in storing additional grain in anticipation of government food aid shipments during poor harvest years.

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I. INTRODUCTION

The present discussion of U.S. food reserves among policymakers apparently originated while preparations were being made for the November 1974 World Food Conference in Rome. By the latter half of 1973, both the executive and legislative branches of the U.S. Government had begun discussing the possibility of rebuilding a government-owned grain stockpile or providing economic incentives to induce the private sector to accumulate increased stocks. At the World Food Conference, organized by the United Nations Food and Agriculture Organization (FAO), representatives of more than 120 nations endorsed FAO Director-General Boerma's "Proposal for World Food Security,"¹ calling for an internationally coordinated system of nationally held cereal stocks to provide world food security.²

Definitions

Although the commodities appropriate for coverage by food stock policies could be disputed, the basic grain cereals (wheat, rice, corn, oats, barley, and grain sorghums) are most often considered the foods appropriate for storage. The basic grain cereals are the staple foodstuffs of people in developing countries, the main source of carbohydrates in high-income countries, and a major input in the production of animal products; they also store better over longer periods of time than other foodstuffs. A subset of these cereals might be appropriate for stockpiling in the United States, or coverage could be expanded to include soybeans, milk powder, or other basic foodstuffs. In what follows, however, we assume stock policy refers to cereal grain stocks.³

Throughout this report, the term "stocks" will mean the amount of cereal carried over in storage at the end of the marketing year—that is, when domestic and export requirements can begin to be met with new crop supplies. These "carryover stocks" are over and above "working stocks," the stocks required to ensure a smooth and uninterrupted flow of supplies from the farmer to the processor and ultimately to the consumer.⁴ Sometimes carryover stocks are termed "reserves."

The definition of food security endorsed by the World Food Conference cannot, by itself, guide policies for promoting world food security. As defined in the text of the Boerma proposal, world food security is "the availability at all times of adequate cereal supplies in the world so as to avoid acute food shortages in the event of widespread crop failures or natural disasters."⁵ Many important economic concepts remain undefined. Before policy alternatives can be analyzed, we must ask ourselves

¹ FAO, *World Food Security: Proposal of the Director-General*.

² President Ford recommended the development of such an international system of nationally held reserve stocks in his September 18, 1974 speech before the United Nations General Assembly, but only at the November Conference was the concept internationally endorsed.

³ See FAO, *World Food Security: Proposal of the Director-General*, p. 8, for a discussion of commodity coverage for a worldwide system of stockpiles.

⁴ These concepts are discussed more fully in FAO, *Report of the Expert Consultation on Cereal Stock Policies*.

⁵ FAO, *World Food Security: Proposal of the Director-General*, p. 3.

what level of food supplies is "adequate," what a "food shortage" is, and how food shortages can be measured.

Food shortages are commonly said to exist when people wish to consume more food than is available. *The larger the difference between desired food consumption and food availability, the larger the food shortage. But such a definition is insufficient because it neglects the effect of prices on desired consumption and availability.* The price responsiveness of food consumption and production suggests that from an economic perspective any concept of food shortages must specify the *level of food prices* at which such a shortage is measured.

Private grain storers accumulate stocks when prices are low in order to profit from an expected increase in price. In so doing they tend to stabilize prices and consumption by increasing the demand when prices are low and increasing the supply when prices are high. As the aggregate level of such buying and selling between markets ("arbitraging") over time is increased, the amplitude of the price fluctuations between times of abundance and times of shortage is diminished. The economic contribution of stockpiling can be evaluated in terms of this effect on the amplitude of price fluctuations. The security of grain supplies in importing countries can be associated with the amplitude of price fluctuations inasmuch as export controls in grain exporting countries are most likely to be imposed when grain prices are abnormally high. Profit-motivated arbitrage will not eliminate all price fluctuations even if markets work perfectly. The stockpile level that private storers in the aggregate maintain in times of low prices will leave room for sufficient expected price increases to compensate for storage costs and risk.

The economic justification for government intervention to raise grain stock levels above their levels determined by the private market lies either in the failure of the private market to operate competitively and thereby allocate supplies in a desirable fashion over time or in the market's failure to incorporate the side benefits ("externalities") of storage not reflected in market demand curves, at either the world or the national level. After presenting background in Section II we examine theory and evidence about storage in the private sector in Section III. We conclude that private grain storage appears to operate under approximately competitive conditions but that the market overlooks a number of externalities involving international diplomatic benefits whose importance we are unable to evaluate precisely.

The Rationale for Government Intervention

In Section III we also consider the commonly stated arguments for government intervention to increase the level of grain stocks above their private-market-determined level. One commonly given but logically incomplete rationale is that stabilization of grain prices, consumption levels, or farm incomes, over and above the stability provided by competitive private sector storage, should be an explicit objective of government policy. But to say that government should provide more stabilization of grain prices than is provided by the private sector is analogous to saying that government should provide more bread or any other commodity than is provided by the competitive private sector. As mentioned, we believe this argument depends on the existence of externalities not taken into account by the private storage market. Thus, this rationale is a generalization of several more specific rationales which

identify various externalities neglected by the private market. We find it convenient to distinguish the following three types of externalities.

First, grain stockpiling beyond the competitively determined level may indirectly promote U.S. objectives in the international diplomatic arena. United States grain stock policies might be a useful bargaining lever in gaining reform of the European Community's (EC's) Common Agricultural Policy (CAP) or in obtaining tariff and nontariff concessions at the current round of multilateral trade negotiations in Geneva. Increased U.S. grain stockpiling might be offered to less developed countries (LDCs) as aid or as indirect compensation for concessions the United States would seek in return. An international system of nationally held reserves, if led by the United States, could further U.S. prestige, or, if such a system included the Soviet Union, it could further détente. These international aspects of U.S. grain stockpiling may be viewed as externalities not reflected in private U.S. grain markets.

Second, an increase in grain stocks beyond their market-determined level may have externality effects on international and domestic food aid programs—PL480 food shipments and domestic school lunch, relief distribution, and other food assistance programs. Food aid can be purchased and donated through various arrangements. Government can accumulate grain stocks in bountiful years for transfer in years of scarcity or, alternatively, can purchase grain for aid purposes in the spot market, only in the amounts and at the times desired. Spot purchasing when supplies are scarce and prices are high is likely to be resisted by taxpayers and consumers competing for the scarce grain. By contrast, if government owns a ready stockpile on which to draw, the amount of food aid contributed might in actuality be more generous. However, we do not discuss the merits of food aid in this report.

Third, dissatisfaction among consumers and producers caused by fluctuating grain prices may impose administrative and political burdens on government, which could be reduced by stabilizing grain prices through an increase in storage levels. Particular domestic groups, such as the livestock producers and meat consumers, may press government to subsidize price stability because their share of the benefits would exceed their share of the tax costs. These pressures may be costly to government. The magnitude of such administrative costs and the advisability of guiding grain stock policy by domestic political objectives are issues we do not take up, although we do mention how various domestic groups would be affected by increased stockpiling.

Two additional rationales for government intervention in the private grain storage market are discussed in Section III, but we find these unconvincing. We discuss the argument that government and the private sector should use different discount rates in evaluating grain stock (or any other) investments. According to this argument, to the extent government spreads risks more widely or takes a longer view than the private market, government may be able to use a lower discount rate in evaluating grain stock investments and thereby produce more price stability than can the private market, while earning a competitive return on any public funds employed. We question the difference between government and private sector discount rates.

Finally we consider the argument that fluctuations in grain prices produce an inflationary pressure on the prices of all goods and services. This effect is alleged to result from a presumed downward inflexibility in wages relative to other goods and

services. However, in our view, this argument confuses the determinants of the relative prices of grain, labor, and other goods and services with the determinants of the general price level.

The United States may decide, on the basis of one or more of the above rationales, that the advantages of maintaining national stocks of basic cereals above their private-market-determined levels outweigh the costs. The precise objective or set of objectives of grain stock policy must be kept firmly in mind when determining the magnitude of desirable government intervention in private sector grain markets.

In Section II we discuss the post-1972 rise in grain prices, the depletion of U.S. and world grain stocks, and changes in world grain production, consumption, and trade. The principal contribution of this study begins in Section III, where we examine the role of private market stockpiling and elaborate on the above arguments for government intervention in private storage markets. The discussion seeks to identify and bring into focus the objectives of increased grain stockpiling. Section IV examines the costs and effects of increased grain stockpiling by surveying existing empirical and theoretical economic studies and presenting some new analysis. Section V contains some observations on the perspectives and positions of foreign countries and domestic groups, relevant for evaluating the international diplomatic arguments for raising the level of U.S. grain stocks and for considering the effects on various U.S. domestic sectors. Section VI calls attention to two problems of implementing stock policies to achieve the desired objectives. Section VII summarizes the entire report and presents our principal conclusions.

II. BACKGROUND: THE 1972-1974 INCREASE IN GRAIN PRICES

This section discusses the 1972-74 rise in grain prices and the background of economic events that led to the present discussion of grain stockpiling among policy-makers. While the explanation for the price rise involves far more than the economics of grain stockpiling, examining 1972-74 events in world grain markets reveals that grain stockpiling policies were not the principal cause of the increase.

Grain prices on U.S. wholesale commodities markets more than tripled between mid-1972 and mid-1974, as is reflected in the selected grain prices shown in Fig. 1.

Commonly cited as direct causes of the grain price increase are the decline in world grain carryover stocks between 1972 and 1973; the decline of world grain production below trend in 1972; increased world affluence and demand for food; large grain purchases by the Soviet Union in 1972; increased prices of fertilizer; and devaluation of the dollar on world markets in 1972. This section presents background statistics describing the roles of these factors.¹

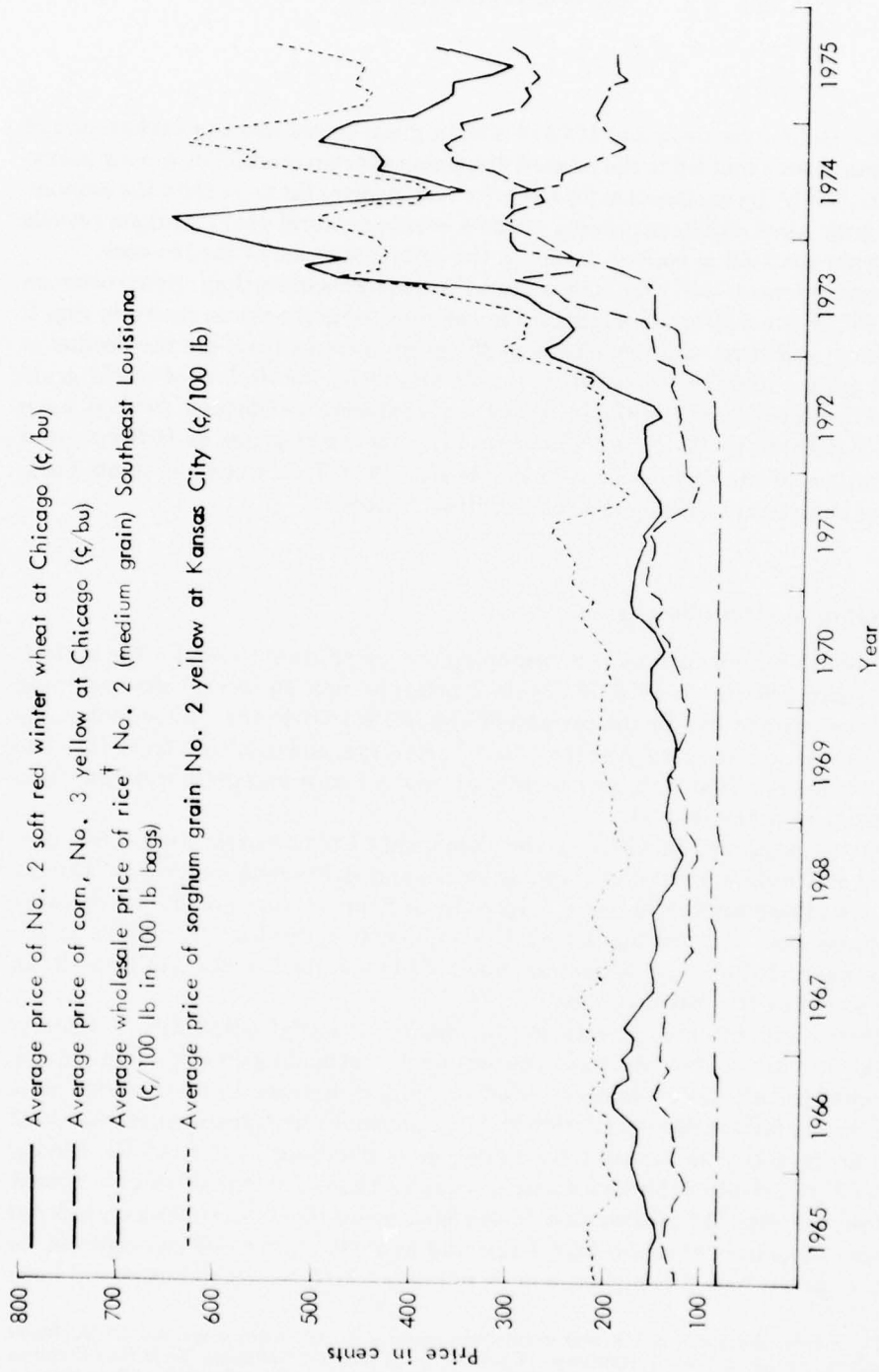
Depletion of Grain Stocks

Table 1 presents data on U.S. beginning carryover grain stocks for the agricultural years 1968/69 to 1975/76. Table 2 presents data on world-wide beginning carryover grain stocks for the period 1960/61 to 1975/76. In the United States, the agricultural or marketing year for wheat, barley, rye, and oats runs from July 1 to June 30, for rice from August 1 to July 31, and for corn and grain sorghum from October 1 to September 30.

At the beginning of 1972/73, the Commodity Credit Corporation (CCC) controlled 46.7 million tons of CCC-owned stocks and stocks held under loan. During that year, these stock levels were reduced by 31.6 million tons and during the next two years were reduced further by 12.1 million to a level of 2.0 million at the beginning of 1974/75. At all times, almost all CCC-owned stocks and loan stocks were stored by the private sector.

Meanwhile, the U.S. private storage market was confronted with conflicting storage incentives. The reduction in government stockholding created incentives for increased private stockholding to offset the initial decrease in total stocks, as is argued more fully in Section IV. However, the unusually high grain prices after 1972 were an incentive to reduce total stocks, as is discussed in Section III. During 1972/73, the private sector increased its stocks by 5.6 million tons as the government reduced its stocks 31.6 million tons. *It may be surmised that total stocks were reduced because prices were at record high levels and no further price rise was expected.* In 1973/74 prices rose still higher, and in retrospect further stockpiling would have

¹ For a fuller discussion of U.S. and world grain markets during recent years, see USDA, *World Agricultural Situation*, Nos. 1-7; Hathaway, "Food Prices and Inflation"; Johnson, *World Food Problems and Prospects*; Sanderson, "The Great Food Fumble"; and Schmittker, "The 1972-73 Food Price Spiral." It was not always possible to update tables in this section to include the latest figures available.



Source: Agricultural Marketing Service, Grain Division, USDA;
Bureau of Labor Statistics

[†] Prior to May 1972, price is for milled NATO at New Orleans.

Fig. 1—Selected grain prices, U.S. wholesale markets
(monthly weighted averages of reported daily cash sales)

Table 1
 U.S. Beginning Carryover Stocks of Wheat and Coarse Grains, 1968/69-1975/76^a
 (In million metric tons)

Year	Wheat				Coarse Grains				Total			
	Under Loan	CCC Owned	"Free" (Residual)	Total	Under Loan	CCC Owned ^b	"Free" (Residual)	Total				
1968/69	6.0	2.8	5.7	14.7 ^c	16.3	10.4	17.3	44.0	22.3	13.2	23.0	58.7 ^c
1969/70	12.3	4.4	5.3	22.2 ^c	16.3	14.1	15.5	45.9	28.6	18.5	20.8	68.1 ^c
1970/71	11.8	8.2	4.0	24.1 ^c	13.4	11.9	18.7	44.0	25.2	20.1	22.7	68.1 ^c
1971/72	5.2	10.1	4.4	19.9 ^c	9.7	7.6	12.8	30.1	14.9	17.7	17.2	50.0 ^c
1972/73	9.1	10.0	4.1	23.5 ^c	19.2	8.4	16.3	45.0	28.3	18.4	20.4	68.5 ^c
1973/74	1.6	3.9	6.2	11.9 ^{c,d}	4.3	5.3	19.8	30.2 ^d	5.9	9.2	26.0	42.1 ^{c,d}
1974/75	(e)	0.2	6.6	6.7 ^{c,d}	0.2	1.6	18.3	20.4 ^d	0.2	1.8	24.9	27.1 ^{c,d}
1975/76	n.a.	n.a.	n.a.	6.3	n.a.	n.a.	n.a.	13.2	n.a.	n.a.	n.a.	19.5

SOURCE: Unpublished USDA table dated January 1975; USDA, *World Agricultural Situation*, WAS-7, June 1975, p. 35.

^aMarketing years are as follows: wheat, barley, and oats, July 1-June 30; corn and grain sorghum, October 1-September 30.

^bIncludes commodities sold but not delivered.

^cIncludes wheat sealed under bond, as follows: 1966/67, 0.1 million tons; 1967/68, 0.02; 1968/69, 0.2; 1969/70, 0.1; 1970/71, 102; 1971/72, 0.3; 1972/73, 0.3.

^dLoan, CCC, and free stocks may not sum to total stocks because total stock data come from a more recent and updated USDA report.

^eLess than 50,000 tons.

Table 2
Worldwide Beginning Carryover Stocks of Wheat and Coarse Grains^a

Category	Year					
	1960/61- 1971/72	1969/70- 1971/72	1972/73	1973/74	1974/75	1975/76
Wheat						
World wheat stocks	72.0	90.8	73.5	50.9	56.3	48.5
Share of world wheat consumption	30%	27%	20%	14%	16%	
Wheat stocks held by the major exporters ^b						
World wheat stocks	52.5	52.6	41.4	22.7	20.0	14.2
Share of world wheat consumption	22%	16%	11%	6%	6%	
Share of major exporters wheat consumption	203%	157%	122%	68%	60%	
U.S. wheat stocks						
World wheat stocks	36.7	22.1	23.5	11.9	6.7	6.3
Share of world wheat consumption	15%	7%	7%	3%	2%	
Share of U.S. wheat consumption	225%	101%	107%	58%	34%	
Share of world stocks	51%	24%	32%	23%	12%	13%
Coarse Grain^c						
World coarse grain stocks	96.4	71.1	73.9	56.3	53.7	41.4
Share of world coarse grain consumption	23%	13%	13%	9%	9%	
Coarse grain stocks held by the major exporters						
World coarse grain stocks	74.6	48.6	53.2	37.3	28.2	19.1
Share of world coarse grain consumption	18%	9%	9%	6%	5%	
Share of major exporters consumption	54%	29%	29%	20%	19%	
U.S. coarse grain stocks						
World coarse grain stocks	70.3	40.4	45.0	30.2	20.4	13.2
Share of world coarse grain consumption	17%	8%	8%	5%	3%	
Share of U.S. coarse grain consumption	57%	28%	28%	19%	16%	
Share of world stocks	73%	57%	61%	54%	38%	32%
Total Wheat and Coarse Grain						
World Wheat and coarse grain stocks	168.4	161.9	147.4	107.2	110.0	89.9
Share of world wheat and coarse grain consumption	26%	19%	16%	11%	12%	
Wheat and coarse grain stocks of the major exporters						
World wheat and coarse grain stocks	127.5	101.2	94.6	60.0	48.2	33.3
Share of world wheat and coarse grain consumption	20%	12%	10%	6%	5%	
Share of major exporters consumption	77%	50%	43%	28%	26%	
U.S. wheat and coarse grain stocks						
World wheat and coarse grain stocks	107.0	62.5	68.5	42.1	27.1	19.5
Share of world wheat and coarse grain consumption	16%	7%	7%	4%	3%	
Share of U.S. consumption	77%	37%	38%	24%	19%	
Share of world stocks	64%	39%	46%	39%	24%	22%

SOURCE: USDA, *World Agricultural Situation*, WAS-7, June 1975, p. 35.

^aStocks data are based on an aggregate of differing local marketing years and should not be construed as representing world stock levels at a fixed point in time. Stocks data are only for selected countries and exclude such important countries as the USSR, The People's Republic of China, and part of Eastern Europe for which stocks data are not available; the aggregate stocks level has, however, been adjusted for estimated year-to-year changes in USSR grain stocks.

^bUnited States, Canada, Australia, and Argentina.

^cIncludes barley, corn, oats, rye, and grain sorghum.

been profitable. In 1973/74 U.S. private stock levels were reduced, this time by 1.1 million tons, apparently with the expectation that prices would rise no further. The reason the increase in grain prices repeatedly exceeded expectations is the subject of the remainder of this section.

Had the government not released so much of its stock when prices rose in 1972/73, more would have been available to alleviate the still higher prices in 1973/74.² However, the release of government stocks helped cushion the price rise in 1972/73 in comparison with what it would otherwise have been, and the further price rise in 1973/74 was unexpected. A number of unexpected events coincided in 1972/73 and 1973/74 to raise prices more rapidly than had been anticipated. But in general it is desirable to deplete stocks to their lowest levels when prices are highest.

Reduced Grain Production

World grain production and consumption for selected years between 1960/61 and 1974/75 are given in Table 3. Production dropped far below trend in 1972/73, but consumption remained above trend through 1973/74, as stocks were reduced. Production in 1973/74 did increase over its 1972/73 low, apparently in response to the increase in grain prices resulting from the 1972/73 shortfall, in conjunction with improved weather conditions.

In early 1973 the U.S. Department of Agriculture (USDA) released most of the wheat and feed grain acreage set aside in 1972/73. In 1974/75 U.S. acreage planted to grain was again increased, but adverse weather led to feed grain yields more than 20 percent below trend, their worst setback in more than 20 years.³

The 1974/75 weather was also adverse in China and South Asia. World production dropped below trend. Grain prices increased to new peaks in October 1974, and consumption dropped below trend. World grain stocks were reduced another 20 million tons, of which 15 million tons were reduced in the United States.

Increased Affluence

Between mid-1971 and the end of 1973 the world experienced a cyclical expansion in GNP,⁴ and this increased the world demand for food. In developed countries, increased affluence particularly increases the demand for meat. Wheat is consumed primarily by humans, whereas coarse grain is primarily fed to livestock. Per capita coarse grain consumption reached 88 percent of total grain consumption in the United States in 1972/73.

Table 4 presents data on per capita wheat and coarse grain consumption in the United States, the Soviet Union, the developed countries, and the LDCs for selected years between 1960/61 and 1974/75. Over the 1960/61 to 1972/73 period, per capita consumption of wheat and feed grains increased throughout the world, which is usually explained by the world-wide increase in affluence over that period.

² See Hathaway, p. 95 ff. for a presentation of this argument

³ USDA, *World Grain Situation*.

⁴ *International Economic Report of the President, 1975*, pp. 1-3.

Table 3
World Grain Production and Consumption with
Trend Estimates 1970-1974
(In million metric tons)

Year	Grain Production			Grain Consumption		
	Actual	Trend ^a	Deviation	Actual	Trend ^a	Deviation
1960/61-						
1962/63	799	793	+6	810	798	+12
1969/70-						
1971/72	1069	1070	-1	1084	1066	+18
1972/73	1101	1132	-31	1131	1126	+5
1973/74	1194	1163	+32	1180	1155	+25
1974/75	1142	1194	-52	1148	1185	-37

SOURCE: USDA, *World Agricultural Situation*, WAS-6, December 1974, p. 27; and WAS-7, June 1975, p. 23.

^aLinear trend is for the years 1960/61 through 1973/74.

Table 4
Per Capita Wheat and Coarse Grain Consumption, in the United States,
the Soviet Union, the Developed Countries, and the
Less Developed Countries, Various Years
(Kilograms)

Year	United States		Soviet Union		Developed Countries ^a		Less Developed Countries ^b	
	Wheat	Coarse Grain	Wheat	Coarse Grain	Wheat	Coarse Grain	Wheat	Coarse Grain
1960/61-								
1962/63	88	658	285	343	116	328	41	58
1969/70-								
1971/72	106	702	394	399	124	386	49	60
1972/73	103	749	402	463	126	407	53	61
1973/74	97	732	401	428	120	411	53	59
1974/75	91	580	352	463	122	368	52	59

SOURCE: USDA, *World Agricultural Situation*, WAS-7, June 1975, pp. 27, 29.

^aUnited States, Canada, Western Europe, South Africa, Japan, Australia, New Zealand.

^bEast Asia, Southeast Asia, South Asia, North Africa/Middle East, Central Africa, East Africa, Middle America, South America.

Note that in 1973/74, in most parts of the world, wheat and coarse grain consumption per capita reversed the upward trend evident since 1960. Between 1972/73 and 1973/74, only in developed countries did coarse grain consumption per capita increase. This occurred mostly in Western Europe, where agricultural policies insulate EC prices from the world market.⁵ By 1974/75, per capita consumption levels in much of the world had retreated from their 1972/73 or 1973/74 highs, except in the Soviet Union, another region in which prices are insulated from the world market. In the Soviet Union, coarse grain consumption in 1974/75 was equal to its high of 1972/73.

As we shall suggest, this insulation of West European and Soviet grain prices explains why much of the 1972-74 increase in world prices of grain was concentrated in the markets of the United States and several other major grain exporters. The sharpest reduction in grain consumption took place for coarse grain consumption in the United States and developed countries. Wheat consumption in the Soviet Union did not decline until 1974/75. Less developed countries, although forced to pay higher prices after 1972/73 for their food and feed grains, did not cut back per capita consumption levels substantially. Adjustment in these countries apparently occurred in other sectors of their economies.

Increased U.S. Exports to the Soviet Union

Wheat and coarse grain exports by the major exporting countries and imports by the Soviet Union for the years 1969/70 to 1974/75 are given in Table 5.

Experts following Soviet agriculture describe an apparent shift in the early 1970s in Soviet policy for handling production shortfalls.⁶ In the mid-1960s, human consumption and livestock herd size were reduced in shortfall years, whereas in 1972/73 consumption and herd size were maintained with grain imports. Soviet grain production had declined 33 million tons in 1963 and 31 million tons in 1965, yet Soviet imports totaled only 10.4 and 9 million tons in those years. By contrast, in 1972/73 the Soviet grain crop was only 13 million tons below 1971/72 production, yet Soviet grain imports increased by 18.2 million tons. To some degree this policy shift was signaled by Soviet imports of 3.4 million tons of feed grains in 1971/72. But the shift was not immediately appreciated. Until late September 1972, the USDA continued an export subsidy policy that priced wheat for export at levels that had been established in the market of 1971/72. Subsidized prices for U.S. exports no doubt helped explain the large Soviet purchases during that year. But no widely distributed forecast indicated that the Russians would import enough grain to more than offset their entire production shortfall. Neither the U.S. Government nor the private sector was prepared for the increase in Soviet imports.

Soviet imports were sharply reduced in 1973/74 and 1974/75 when world grain prices were high, and are increasing in 1975/76 now that grain prices have retreated somewhat. If this pattern reflects price responsiveness in Soviet grain purchasing

⁵ USDA, *World Agricultural Situation*, WAS-7, p. 29.

⁶ See Johnson, "Soviet Agriculture and World Trade in Farm Products," and Schoonover, "The Soviet Feed-Livestock Economy," for a discussion of prospects for U.S. agricultural trade with the Soviet Union. See also Trager, *Amber Waves of Grain*, for a detailed anecdotal account of the 1972 Soviet grain purchase.

Table 5

Wheat and Coarse Grain Trade 1970/71 to 1974/75:
Net Exports by Major Exporters and Net Imports
by the Soviet Union
(In million metric tons)

Year	Wheat Exports by Major Exporters ^a	Coarse Grain Exports by Major Exporters ^b	Wheat Net Imports by Soviet Union	Coarse Grain Net Imports by Soviet Union
1969/70-				
1971/72	39.3	36.8	-4.8	-0.5
1971/72	40.8	38.0	-2.1	3.4
1972/73	55.0	54.1	13.6	5.9
1973/74	52.8	61.4	-0.6	4.9
1974/75	52.5	49.5	-1.0	2.0

SOURCE: USDA, *World Agricultural Situation*, WAS-Supp., October 1972, p. 6; WAS-4, December 1973, pp. 25, 26; WAS-7, June 1975, pp. 32, 33.

^aUnited States, Canada, Australia/New Zealand, Argentina, South Africa, and nine European Community Countries.

^bUnited States, Canada, Australia/New Zealand, Argentina, South Africa, Southeast Asia, East Africa.

and if Soviet purchases in the future continue to be somewhat countercyclical, then Soviet grain purchases could become a stabilizing rather than a destabilizing force in world grain markets. However, so far we have too few years of experience with what appears to be the Russians' new import policy for us to generalize about their import patterns, even given the recent U.S./Soviet agreement on minimum levels of grain trade. That agreement will stabilize U.S. grain exports only if the Soviet Union stockpiles grain in surplus years so as not to disrupt world markets and raise import prices in years when Soviet crops fail. The role of the Soviet Union's grain import demand in grain stock issues is discussed more fully in Section V.

Higher Nongrain Prices

Table 6 presents three price series over the 1970-75 period, for the U.S. dollar, for all U.S. consumer goods and services, and for fertilizers used in the United States. The U.S. consumer price index for all items rose 18 percent between 1972 and 1974, from 125.3 to 147.7 in 1967 prices. Thus, the increase in grain price clearly exceeded the price inflation of other consumer goods and services.

If U.S. grain prices were set in world markets so that dollar grain prices rose in step with devaluation of the U.S. dollar, this would explain up to a 17 percent increase in U.S. dollar grain prices since 1970.⁷ However, dollar devaluation may help explain why the average level of annual U.S. exports of all grains rose 35 to 40 percent between the periods 1969-1972 and 1972-1975.⁸

⁷ For a fuller discussion of the role of dollar devaluation in the development of U.S. agriculture since World War II, see Schuh, "The Exchange Rate and U.S. Agriculture."

⁸ USDA, *World Agriculture Situation*, WAS-7, p. 27.

Table 6
Selected Nongrain Prices, 1970 to 1975

Year	Effective U.S. Dollar Devaluation Cumulative Since May 1970 ^d (%)	Consumer Price Index U.S. (All items) 1967 = 100	Fertilizer Prices (dollars per short ton)					
			Nitrogen Fertilizers					
			Elemental:		Natural:		Phosphate Rock	Potash ^b
Pipeline Gas	Bulk Liquid	Fixed: Ammonia	Sodium Nitrate, Bulk					
1970	2	116.3 ^c	--	--	--	--	5.25	19.64
1971	5	121.3 ^c	8.16	46.80	56.00	51.50	5.24	22.30
1972	10	125.3 ^c	7.48	41.85	60.00	51.50	5.09	22.50
1973	17	133.1 ^c	7.20 ^d	43.07 ^d	65.00 ^d	51.50 ^d	5.66 ^d	23.92
1974	16	147.7 ^c	8.13 ^d	43.12 ^d	140.00 ^d	75.00 ^d	9.00 ^d	33.64
1975	17 ^e	160.6 ^f	--	--	--	--	--	--

SOURCES: IMF and the Federal Reserve Bank of New York, as reported in Kemp, "Balance of Payment Concepts"; U.S. Bureau of Labor Statistics; U.S. Bureau of Mines, as reported in *Commodity Year Book 1975*, Commodity Research Bureau, Inc., and *Mineral Industries Surveys, Advance Summary: Potash on a Calendar Basis, 1974*.

^aEffective devaluation is measured by the appreciation of eleven major currencies relative to the par values that prevailed as of May 1970. The appreciation is then weighted by separate export and import shares with the United States based on 1972 trade data. Approximate annual averages were read from a diagram of monthly figures.

^b20 lb K₂O per ton.

^cAnnual average.

^dEstimates.

^eJanuary to May average.

^fMonth of June.

Fertilizer prices did not rise sharply until 1974. Between 1972 and 1974, consumption of nitrogen, phosphate, and potash fertilizers increased, respectively, by 37, 21, and 26 percent in developing countries; 37, 30, and 34 percent in centrally planned economies; 18, 13, and 16 percent in the United States; and 14, 14, and 15 percent in developed economies generally.⁹ In the long run, higher fertilizer prices could reduce fertilizer applications and thereby reduce yields, leading to smaller crops and higher prices. But fertilizer prices explain neither the 1972/73 shortfall in world grain production nor the large increase in grain prices in 1973. They may, however, indicate that grain prices will not fully retreat to their pre-1973 levels.

Conclusion: Why Did Grain Prices Rise?

When all the above factors are added, plus increased world demand for feed grains due to a decline in fishmeal production in 1973, no more than about a 65 percent increase in grain prices is explained, according to an analysis by Johnson.¹⁰

⁹ *Ibid.*, WAS-5, pp. 21-23

¹⁰ Johnson, *World Food Problems and Prospects*, pp. 21-34.

Some would argue that Johnson's figure is too low. Johnson suggests that the residual increase can be explained only by the administered price policies followed by governments in several large countries. While a two- and threefold increase in grain prices was observed between mid-1972 and mid-1974 in the United States, Canada, and Australia, where prices followed market forces, in the EC grain prices received by farmers rose at most 20 percent, except in Italy, where they rose 40 percent. In the Soviet Union, prices reportedly remained unchanged. Some LDCs maintained low grain prices to consumers. Thus *the consequences of the modest world production shortfalls of 1972 through 1974 were shared by only a part of the world grain market*. Johnson concludes:

The international market could have absorbed the production shortfalls with a rather modest increase in prices if producers and consumers in all nations had been given proper price signals. But such was not the case. As a consequence, consumers in many developing countries and in the major exporting nations were forced to pay much higher prices for grain products than those nations whose governments insulated them from the effects of production variability.¹¹

¹¹ Ibid., p. 34. The United States could have fully insulated U.S. grain prices from world market conditions by restricting grain exports. Furthermore, the United States could probably exploit its dominant position in world grain production by organizing its grain exports monopolistically to increase grain export earnings. However, such policies are beyond the scope of this report.

III. THE OBJECTIVES OF GOVERNMENT INTERVENTION IN PRIVATE STORAGE MARKETS

Profit incentives lead to private storage, irrespective of the underlying source of price variability. Private storers seek to profit from whatever price fluctuations appear in the market in which they operate, regardless of whether the price fluctuations are due to rigidities in world trade that prevent production shortfalls from being dissipated throughout world grain markets, changeable buying habits of centrally planned economies, or unavoidable fluctuations in weather and natural events. In setting spot and future prices, the private commodity market takes into account, and therefore reflects, whatever information is available on all demand and supply uncertainties and trends. Once the instability, uncertainty, or structural shift is reflected in spot and futures prices, the actual source of instability is no longer directly relevant for determining desirable stock policies. If individual grain storers disagree with how the market reflects the available information, they express their disagreement by buying or selling in the spot or futures market in order to profit from the movement they expect to occur when additional information becomes incorporated in the market.

Thus, *interferences in world trade in grain, or any other explanation for observed fluctuations in grain markets, are not in themselves justifications for government intervention in grain storage markets.* If trade liberalization can eliminate some of the instability in U.S. grain markets, then such liberalization could be pursued. But grain stock policies should be considered on their own merits, taking market fluctuations as given.

Accepting that grain prices fluctuate, we may ask how private storers respond, and how government might supplement their stabilizing activities. This study takes the position that government intervention in grain storage markets can be justified only to (1) correct a failure of the private market to operate competitively or (2) incorporate nonmarket externalities.

Grain "Shortages"

To focus on the possible objectives of a government policy to raise grain stocks above their market-determined levels, it is useful first to understand the motivation and rationale behind private market stockpiling. The market solution to the grain reserves problem can then be viewed as a baseline solution that may be adjusted by judicious government intervention to correct specific imperfections and distortions.

To develop a theory of storage we need two schedules: the consumers' demand schedule for grain consumption and the producers' supply schedule for grain production. At first, we abstract from the possibility of grain stockpiling and assume all grain production must be consumed in the year in which it is produced.

For expository purposes, we analyze a market in which the demand schedule is invariant from year to year but the supply schedule shifts or varies. In U.S. grain markets, the chief sources of variability are fluctuations in the U.S. supply schedule

due to weather and natural causes, and fluctuations in the U.S. export demand schedule due to various factors abroad. Both types of fluctuations may be incorporated in fluctuations in the supply schedule by considering a market with a supply schedule equal to the net of U.S. production less exports, that is, the supply schedule that faces domestic U.S. consumers. The U.S. domestic demand schedule, which combines both food and feed grain demand, changes gradually in response to growth in population and income, but these factors are ignored in our discussion.

Figure 2 depicts the domestic demand schedule for grain, D , and two short-run domestic supply schedules (net of export demand), S_L and S_B , one for a lean and one for a bountiful harvest year. The supply schedules are assumed to be perfectly inelastic (vertical) in the short run. If consumption, production, and the market price during lean and bountiful harvests are determined by the intersection of demand and supply schedules, then (P_L, Q_L) and (P_B, Q_B) are the price/quantity combinations that prevail for lean and bountiful years, respectively.

The size of any grain "shortage" depends on the price of grain selected. If we measure grain shortages in lean years at price P_L , the quantity of consumption desired and the quantity of grain available would be identical, and no shortage would exist. If we measure shortages during lean years at the price that prevails during bountiful years, P_B , then the shortage equals the excess of the level of desired consumption, Q_B , over the quantity of grain supplied, Q_L . Alternatively, if we measure the shortage at a price greater than P_B , say P_I , there is a smaller shortage because the level of desired consumption, Q_I^D , is closer to the quantity of grain available, Q_L .

Thus, the definition of a grain shortage and its measurement depends on what one believes the relevant price of grain is for years of lean harvests, that is, the reference price one has in mind when speaking of shortages. The discussion of grain stockpiling policy has not suggested what this relevant price of grain during lean

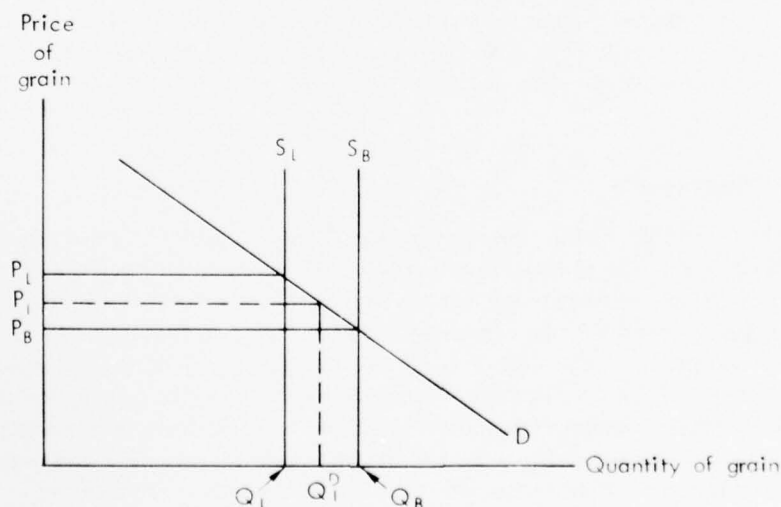


Fig. 2—Grain demand and supply during lean and bountiful harvests

years ought to be. The private market itself does not allow the price of grain to increase to P_L in those years.

The Role of Private Storers

Confronted with the given fluctuations in supply, consumers and producers would each benefit from redistributing grain from bountiful to lean years, because an additional bushel of grain is more valuable during lean harvest years than during bountiful harvest years, being worth P_L in a lean year and P_B in a bountiful year. Both consumers and producers would be better off if grain sales did not fall to Q_L during lean years.

When the possibility of storage is introduced, the private storage market accumulates grain in bountiful years for resale in future years to profit from the expected increase in price. Storers may be producers, middlemen, final users, or specialized storers. In general, all these groups can be expected to store grain when storage is profitable. By storing, the private market realizes the gains of consumers and producers from redistributing supplies from bountiful to lean years. During lean years, consumption does not fall to Q_L , nor does market price rise to P_L . The actual levels of grain consumption and market price in lean years depend on the level of storage activity.

Storers will stockpile grain during bountiful harvests to sell in the future if the expected price appreciation between present and future dates exceeds the expected cost of storage (defined below). Storers will not accumulate so much stock as to narrow the expected range of price fluctuations to the point where storage becomes unprofitable. They may be expected to expand storage activities until the resulting range of price fluctuations just covers the cost of storage, since this will yield the competitive rate of return on the resources used. Still, some of the price and consumption fluctuations will remain.¹

The cost of grain storage is the sum of the cost of using the storage facilities for the number of years for which the grain is stored and the "opportunity cost" of funds invested in the stored grain, that is, the return on the next best investment opportunity foregone in the process of purchasing and storing grain. To the extent that storers are "risk-averse" (require a higher expected return on risky investments), the opportunity cost should reflect the riskiness of storage investments. We argue later on in this section that both the private sector and the government face the same opportunity cost in making grain stock investments.²

The quantities of storage space supplied and demanded in the short run respond to and influence the relationship between grain spot and futures prices.³ This rela-

¹ Blau, "Some Aspects of the Theory of Futures Trading," examined this equilibrium degree of price variability and hypothesized that private market speculative activity might allow more than this degree of variability to remain in the market if speculators act in a destabilizing fashion, by basing their market activity on their forecasts of the reactions of other speculators rather than on the trend of nonspeculative forces in the market. This idea was originally formulated by Keynes in *The General Theory*, pp. 154-158. However, the existence of destabilizing speculation has not been demonstrated by empirical analysis.

² We discuss private sector and government attitudes toward risk on pp. 23ff.

³ See Working, "The Theory of Price of Storage," and Telser, "Futures Trading and the Storage of Cotton and Wheat."

tionship also depends on hedging, speculation, underlying demand and supply conditions for grain, price relationships over space, and other factors.⁴

The Competitiveness of Private Storage

Economic theory shows that in competitive storage markets the profitable level of grain storage provides the socially desirable level of protection against fluctuations in grain prices. The grain storage market can be considered competitive if the following conditions are satisfied: (1) Many traders and storers demand and supply grain storage, so that no one storer or trader influences the physical cost of storage or the relationship between spot and futures prices. (2) The grain storage services of different firms in the industry are perfectly homogeneous and substitutable. (3) Resources can move freely in and out of the storage business. (4) All units operating in the market have access to existing information about current and expected future grain production, consumption, and stocks. (5) The costs and benefits of grain production, consumption, and storage are fully reflected in the supply and the demand schedules.

The entire grain sector in the United States, including the grain storage market, is generally considered to be among the most competitive of U.S. sectors.⁵ The few statistics that we have seen regarding the distribution of the ownership of storage space in the United States indicate that its supply is not controlled by a small number of firms. A large share of U.S. grain stocks is stored by farmers, suggesting that grain trading companies do not monopolize storage activity. For example, during the 1967/68 to 1975/76 period, approximately one-third of the wheat stocks, two-thirds of the corn stocks, three-fifths of the barley stocks, two-fifths of the oat stocks, and one-fifth of the sorghum grain and rye stocks carried over at the end of the year were stored on the farm.⁶ In addition, as of early 1975 there are nearly 6 billion bushels of off-farm grain storage capacity. However, we have information only on terminal and subterminal storage capacity ("official capacity") owned by multiple-elevator companies, a total of 1.1 billion bushels of capacity. The three largest multiple-elevator companies (Cargill, Continental, Far-Mar-Co.) own 362 million bushels, or 34 percent, of this official capacity.⁷ The remaining 68 percent capacity is owned by 46 companies, each of which owns less than 65 million bushels of capacity. The nearly 5 billion bushels of off-farm storage space, for which we have no statistics, is official capacity owned by single-elevator companies and capacity in country elevators. The share of grain storage capacity owned by the few largest firms is apparently quite modest, by the standards of market concentration used in the industrial organization literature.⁸

A wide range of hypotheses regarding cash and futures price relationships has

⁴ The grain storage and marketing processes are not described in this report. Readers may refer to Hieronymus, *The Economics of Futures Trading*, a textbook covering the subject. A full understanding of the storage process requires consideration of at least the roles of grain farmers, country elevators, interior merchants, ingredient merchants, livestock producers, cash grain merchants, terminal elevators, millers, exporters, and integrated merchants.

⁵ See Hieronymus, Chapter 5.

⁶ Commodity Research Bureau, inc., *Commodity Yearbook 1975*.

⁷ *Milling and Grain Directory 1975*, pp. 153-164. The official storage capacity owned by the Bunge Corporation is not indicated.

⁸ See Stigler, *The Organization of Industry*, Chapters 4 and 13.

been examined in the economics literature.⁹ We conclude from the literature that the markets for cash grain and grain futures involve many investors and are highly competitive. For example, an analysis of the structure of open interest in corn futures on January 27, 1967 by the Commodity Exchange Authority¹⁰ revealed the presence of 13,224 individual accounts. Of these, 2,002 were trade-associated, held by merchants, warehousemen, processors, feed manufacturers, etc., and 11,022 were held by individuals of a wide range of occupations unrelated to the grain trade. The geographic distribution was world-wide, involving all states of the United States and 25 foreign countries.

Grain storage services can be considered homogeneous, since in the long run the services of various grain storage facilities are highly interchangeable. In the short run, storage facilities in different locations are not perfectly substitutable because shipment of grain from one location to another takes time and money. Occasionally, individual elevator companies may be able to exert some monopoly influence on the price of storage in a particular region, but in the longer run the storage facilities located elsewhere are competitive.

The possibility of moving grain in or out of bins and elevators on the farms, at railroads, and elsewhere facilitates the movement of resources in and out of the storage business. The financing arrangements in this business make grain storage investments particularly liquid. Grain may be purchased for storage on margins of less than 10 percent with loans at prime rates of interest, provided the inventories are offset by short positions in futures markets.¹¹

A vast amount of information regarding current and anticipated domestic and export supply and demand conditions, stock levels, and government policies is made widely available by the USDA, the individual grain markets, and private reporting services.

To assume that the benefits and costs of grain consumption and production can be determined from the demand and the supply schedules involves assuming that such benefits and costs are indicated by the maximum amount of money that people can be made to pay for this consumption and the minimum amount they would accept for its production. This assumption is explained further in Section IV, where we discuss the welfare effects of grain stockpiling.

Accepting, on the basis of the discussion above, that grain storage markets are competitive, then the level of grain storage provided by the private market is optimal in the following sense: The value of storing one more bushel for sale and consumption in a future period and paying storage costs would be expected to be less than the value of selling and consuming that bushel in the present period. Conversely, the value of storing one less bushel and consuming it in the present period would be less than the expected value of storing that bushel for sale and consumption in a future period and paying the storage costs. Gustafson demonstrated this result in his empirical study of U.S. grain stockpiling during 1901-1950.¹² He concluded that private storers in the aggregate hold approximately optimal stock levels.

⁹ For example, see Working, "Speculation on Hedging Markets"; Gray, "Fundamental Price Behavior Characteristics in Commodity Futures"; Cootner, "Speculation and Hedging"; Dusak, "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums"; and Labys and Granger, *Speculation, Hedging and Commodity Price Forecasts*.

¹⁰ "Trading in Corn Futures, September 1966—March 1967."

¹¹ See Hieronymus, pp. 129-135, for a discussion of financing arrangements in grain futures markets.

¹² *Carryover Levels of Grain*.

THE OBJECTIVES OF INCREASED GRAIN STOCKPILING

The most common arguments for government intervention in private storage markets to increase the level of grain stocks can be classified into several basic types, presented below. The arguments we find to be valid relate to possible externality costs or benefits of stockpiling that are not taken into account by the private sector.

Grain Stocks for Price Stability

As we have indicated, when grain is stored by a competitive private storage market, some price and consumption fluctuations are eliminated but some remain. There is a persistent argument that additional redistribution of grain from bountiful to lean years benefits consumers and producers and will justify government storage costs to increase price stability beyond the level generated in the private market. If the demand schedule is stable, price stability leads to consumption stability.

However, this "stability for stability's sake" argument cannot justify more than the level of price stability provided by the private market. *While additional price stabilization would be desirable because it is an economic good that benefits society, this benefit must be balanced against the costs of providing it.* Since private storers balance the additional market gains and costs of stabilization, the extra stability that government could supply would not be expected to be worth to society what taxpayers would have to pay in storage costs.¹³ Government intervention in grain storage markets must be justified on the basis of specific externalities which the private market does not take into account.

U.S. Grain Stocks to Further National Objectives in the International Arena

A number of U.S. objectives in the international arena might be furthered by U.S. grain stockpiling, either automatically by a unilateral U.S. increase in grain stocks or by a multilateral agreement on stockpiling or trade. In each case the externality benefits are national and are thus not reflected in private market demand and supply schedules. *To the extent that the connections between U.S. grain stock policy and U.S. international objectives are realistic and valuable, these connections would justify some government expense for increasing grain stock levels.* We present below the international externality arguments we have encountered and comment on their importance in Section V.

If the United States unilaterally increased its grain stockpiling activity, world prices would be to some extent stabilized. Extremely high prices would be less likely, as would domestic political pressure for U.S. export embargoes, which arises when prices are extremely high. If U.S. export supplies were a more secure food source, the EC, the Japanese, and others might be more willing to relax protection of their own agricultural sectors (so the argument goes) to reduce the consumer and taxpay-

¹³ In the cases of other types of risk protection, for example health and car insurance, few people consider it worthwhile to fully insure against all costly contingencies. Just as it is not worthwhile to fully insure in these cases, it is not worthwhile to fully protect against fluctuations in grain prices.

er costs of tariff-protected grain prices and subsidized agricultural production. Importers of U.S. agricultural exports would be less likely to seek out alternative suppliers, as the Japanese have done in Brazil with soybeans, to diversify their import sources, and protect their food supply from trade embargoes. Eventually, the reduced trade barriers in world agricultural markets would lead to an expansion in U.S. grain exports.

More specifically, U.S. export gains would be achieved if the EC could be induced to withdraw its subsidy of exports of surplus agricultural products, which compete with U.S. exports. At present, the CAP has no provision for automatic production cutbacks or stockpiling of surplus production—alternative ways of handling the surplus production problem resulting from subsidized agriculture. If the EC merely agreed to set up the administrative machinery for such grain stockpiling (or production cutbacks), regardless of the size of the program, this could be to the advantage of the United States and could be argued to balance the cost of a U.S. grain stock program, because it would at least facilitate the eventual removal of the EC's export subsidization practices.

Conceivably, U.S. export gains could also be achieved by tying U.S. grain stockpiling and stable U.S. grain export prices to reciprocal concessions on the part of the EC, Japan, or other countries at the current round of Multilateral Trade Negotiations in Geneva. United States objectives at the negotiations include reductions in EC import tariff barriers to U.S. agricultural exports, and in EC nontariff barriers to agricultural trade, such as production and export subsidies. Other U.S. objectives more broadly include general reductions in tariff and nontariff trade barriers to agricultural and nonagricultural commodities, and assurance of regular supplies of primary commodities from LDCs.

It can be argued that U.S. grain stocks, by stabilizing world grain prices and consumption levels, further the following U.S. political objectives with respect to developing countries: (1) increased political stability in poor countries, otherwise threatened by sharp fluctuations in food prices; (2) increased economic development brought about by reducing uncertainties associated with forecasting import expenditures; (3) a rebuilding of U.S. prestige in the wake of Vietnam, achieved by projecting U.S. leadership in solving the food problems of the world's poor; and (4) a demonstration of responsible behavior on the part of the United States with respect to its main export, food, which might be hoped to induce LDCs not to restrict their export supplies of raw materials and other commodities.

It might be argued that increased U.S. grain stockpiling leads to more stable prices and reliable U.S. export supplies, to Soviet (and perhaps Communist Chinese) reliance on U.S. grain exports, to East/West economic integration and eventually to relaxation of costly political and military tensions.

A final national argument for increased U.S. grain stocks hinges on inducing other countries to share storage costs born by the U.S. Government. Such an arrangement could be achieved only through a negotiated agreement, in which stable prices and reliable U.S. export supplies were offered in exchange for foreign contributions to a U.S. storage program.

The negotiating value of increased U.S. grain stocks is discussed and partially evaluated in Sections V and VI, which deal with political and implementation aspects of increased U.S. grain stockpiling. The fact that most foreign countries have the option of operating their own stockpiling programs to stabilize grain prices and

guarantee supplies limits the negotiating value of increased U.S. grain stocks. At the same time, most of the concessions which the United States seeks from foreign countries appear to be relatively valuable to those countries. However, to the extent increased U.S. grain stocks have negotiating value and grain stock policy is the most effective tool for attaining international objectives, this value represents a market externality that would justify raising the level of U.S. grain stocks above their private-market-determined levels.

Grain Stocks for Food Aid

Conceptually, food aid and grain stock issues could be settled sequentially. First, the desired expenditure for food aid purposes would be determined. Next, the administrators of this budget would decide whether to (1) accumulate food reserves when food prices were low, specifically for aid purposes later on; (2) buy food in the spot market only at the times and in the quantities needed; (3) purchase, in the futures market, options to buy food later for aid use; or (4) transfer the cash to needy people for their own use in purchasing food or whatever they wanted more. This is not the place to discuss the merits of food aid, but it is appropriate to indicate here how grain stock policy may influence food aid policy, and vice versa.

Government demand for grain for food aid purposes should be announced as far ahead of time as possible to allow the private storage market to take this demand into account.¹⁴ If planned government expenditures for food aid are made known to the private market in sufficient time, or if government food aid policies are predictably tied to market conditions, the private market can be expected to increase its grain stocks in anticipation of the government food aid purchases in times of shortage. *The private market will strive to predict and account for food aid purchases, even if the government does not specify its intended food aid demand.* The additional private storage tends to raise prices in abundant years and diminish them in lean years, thereby diminishing the cost of spot purchasing grain for food aid when the demand arises. Because the private sector can be expected to adjust its storage policies to accommodate the level and pattern of government food aid purchases, it is not obvious whether food aid can be provided more cheaply through government stockpiles, spot purchases, or forward contracts.

However, *on political grounds, it may make sense to stockpile for aid requirements when prices are lowest, because this times the food aid purchases to occur when consumers and taxpayers are least sensitive about cost and diverted food supplies.* By stockpiling grain the government is hedging its uncertain food aid requirements in the futures market. *Government purchase of call options could provide a similar hedge.* Of course, taxpayers and consumers may protest the shipment of government grain stocks during production shortfalls regardless of when the stocks were accumulated; they may argue that stocks should be used domestically to reduce spot market prices.

The level of resources devoted to food aid may itself be influenced by government food stock policies so that food for aid purposes becomes an externality effect of government grain stocks held for whatever purpose. Food donations to foreign coun-

¹⁴ This announcement could be implemented by purchasing call options.

tries through the PL480 program and to needy people in the United States through school lunch, domestic relief distribution, and other domestic food assistance programs have in the past been the results of accumulating unwanted CCC stocks. Politically, it may be easier to allocate resources for food aid indirectly as a side benefit to a grain stock plan rather than directly, as would be necessary if there were no government grain stocks and food aid had to be obtained on the spot market.

Price Stabilization to Reduce Domestic Political Instability

Substantial price variability exacerbates conflicts among grain producers and consumers (including grain processors and livestock producers), and it may be argued that the resultant dissatisfaction imposes externality costs on government. Grain is an input in livestock production, and high and low grain prices benefit grain and livestock producers and consumers differently. Whether grain prices are high or low, some sectors suffer at the expense of others.

Market operators are free to protect themselves against such price variation with futures contracts and their own stockpiling schemes, but such hedging is only partially used. By remaining partially unprotected against price fluctuations, grain producers, traders, and users reveal their belief that the additional protection justifies neither the storage costs nor the premium in a futures contract, unless others can be made to pay for these costs.

Although partially unprotected by choice, dissatisfied grain buyers and sellers will protest when grain prices move adversely and inordinately. Although unjustified, their complaints may burden government with administrative expenses that could be avoided by stockpiling and providing price stabilization at taxpayer expense. Conceivably, government-induced price stabilization could avert sufficient administrative costs to outweigh the cost of the increased stabilization. Unfortunately, *we know of no reliable way to evaluate the government administrative costs due to severe price swings, and thus to evaluate the amount of increased price stability justified by this argument.*

Differential Government and Private Sector Discount Rates

The discount rate appropriate to use in evaluating proposed government projects has long been an issue in the economics literature. Government intervention in the private storage market is sometimes espoused on the basis that government discount rates are, or should be, lower than private sector discount rates. This proposition is usually supported by either of two arguments, one related to an alleged ability of government to diversify risk more fully than the private sector, and another related to an alleged responsibility of government to use a lower discount rate than the private sector in order to defend the interests of future generations.

Those who believe government is better able than the private sector to diversify risks from grain storage assume that the mere size of the government allows it to pool grain storage risks with independent risks from other government projects. Conversely, private storers, unable to so diversify risk, are alleged to be overburdened with nondiversified risk, which increases the expected rate of return they

require on invested capital. As a consequence, the private sector would store grain only to the level at which the expected profit from storage covers both the cost of storage and the overvalued risk. Government, by diversifying its risks and thereby lowering its risk burden, would be able to profitably store grain beyond the level stored by the market. This argument amounts to the proposition that government stockpiling would be profitable and therefore beneficial both to taxpayers and price stabilization interests. This argument could not be used to justify stockpiling that did not cover storage costs in the long run.

However, this argument ignores the possibilities for diversification of risk in the private market. The commodity and equity markets allow individual private investors to diversify storage risks by purchasing small shares in many assets. They can own small quantities of various types of stored grain, and they can purchase shares of corporations that own grain stockpiles. The large integrated grain marketing and exporting firms, most of which are not publicly owned, operate subsidiaries in non-agricultural industries and thereby spread their storage risks throughout the economy. By contrast, the government sector is less than one-fourth the size of the private sector in the United States and may be less able to diversify risks than the private sector, despite its size advantage over individual firms. Thus, it is not at all obvious whether government or the private market is better able to diversify risks.¹⁵

Some argue that government takes or should take a longer investment view than the private market, because government acts, or should act, as trustee for the interests of future generations. This "claim of posterity" argument is espoused by Feldstein,¹⁶ who traces it back to the nineteenth-century writings of Böhm-Bawerk. Feldstein concludes that government's judgment of the relative social utility of consumption at different points in time should be used as the social discount rate for evaluating proposed government projects.¹⁷

Hirshleifer¹⁸ dismisses the claim-of-posterity argument on efficiency grounds. The adoption, say, of a 5 percent discount rate for government stockpiling or any other investments and a 10 percent discount rate for private investments would mean that there would be investments in the private sector not undertaken because they would not be justified except for discount rates of, say, below 9 percent. Meanwhile, however, government projects yielding only 5 percent would be adopted in the public sector. The disparity of private and public interest rates would lead to the adoption of public projects that were less productive than private projects not being adopted. The disparity of interest rates would mean that, given the aggregate amount of present investment, less would be provided for the future when less

¹⁵ Prominent economists have based their support of government intervention in commodity storage markets on the supposition that government can diversify risks that the private sector cannot. This argument was advanced as early as 1938 by Keynes in "The Policy of Government Storage of Foodstuffs and Raw Materials" and "The International Control of Raw Materials," and as late as 1967 by Houthakker, *Economic Policy for the Farm Sector*. But these authors posit rather than analyze this supposition, and they ignore both the private sector opportunities for diversification of storage risks and the limitations of risk diversification by the government. Hillman, Johnson, and Gray, *Food Reserve Policies for World Food Security* (p. 2), find the risk diversification argument for government intervention "unconvincing."

¹⁶ "The Social Time Preference Discount Rate in Cost Benefit Analysis."

¹⁷ Averting famines might be considered to come under a government mandate to act as trustee for future generations. But emergency food relief essentially involves government's responsibility to redistribute income and wealth to achieve a more equitable overall distribution. The food aid justification for government intervention in grain stockpiling has already been discussed.

¹⁸ "Social Time Preference."

productive investments were undertaken. Even if it were agreed that there was insufficient provision for the future, the remedy would be to squeeze current consumption (increase real savings) but enforce a common interest rate throughout society.

In summary, a differential between private and government discount rates can be concluded only from a partial analysis that overlooks the potential for private sector risk diversification or that narrowly considers the claim of posterity for public sector investments only. The case for different public and private sector discount rates does not appear to be a strong enough basis on which to justify government intervention in private sector grain storage.

Grain Reserves to Reduce Inflationary Pressure

Some have argued that fluctuations in grain prices contribute to inflation.¹⁹ Grain prices in cash grain markets are generally accepted to be highly flexible upwards and downwards, but it is argued that wages and salaries in many industries are flexible only upwards, tending to rise when the cost of living rises, but not fall when the cost of living falls. Fluctuations in grain prices are said to cause intermittent increases in salaries and wages (a "ratchet effect") that contribute to inflation. According to this argument, grain stockpiling to stabilize prices would reduce inflation.

Even accepting, for the moment, the validity of this ratchet effect, it would not be quantitatively very important. The wholesale value of domestically used wheat and feed grain represents about 2 percent of U.S. disposable personal income, so that each 25 percent increase in wholesale grain prices would raise the cost of living, and therefore wages and salaries, by at most 0.5 percent, according to the above argument, while each 25 percent decrease in wholesale grain prices would have no effect. Both the direct effect of grain prices on the cost of living and first-round indirect effects through bread and meat prices are included by the above calculation. It ignores decreases in the consumption of grain and meat that would follow from increases in their relative prices, and these adjustments would moderate the calculated change in the cost of living. We are not suggesting that the near trebling of grain prices since 1972 did not appear as a sharp increase in the consumer price index, but rather that the presumed rigidities in price fluctuations are unimportant.

More fundamentally, the belief that inflationary pressures arise from fluctuations in grain prices stems from a basic confusion between the forces which cause changes in *relative* prices and those which affect the general price *level*, in our view. While it is quite true that an increase in the price of grain would initially raise the price of grain-intensive goods such as bread and meat, it is not true that this effect would spill over to higher prices for all goods and services. The increased use of dollars to buy grain-intensive items would leave less money to spend on other items, and this would exert a downward pressure on the prices of the latter. By contrast, a rise in the price level, that is, a rise in the average price of all goods and services, occurs when we have more money to spend on an unchanged stock of goods and services, or when we have the same amount of money to spend on a smaller quantity.

¹⁹ For example, Gray makes this argument in "Grain Stock Issues."

The ratchet effect is not argued to influence either the amount of money or goods in the economy.

Conclusions

In summary, we find two types of logically plausible objectives for government intervention in private grain storage markets: national objectives in the international arena and an increase in the level of food aid. In Sections V and VI, we comment on the possible contribution of increased grain stockpiling toward achieving these objectives. Increased grain stockpiling could also be used to reduce the cost to government of dealing with protests of grain consumers and producers arising from fluctuations in grain prices, if indeed these costs are important. Grain stock policy should not be based on a supposed differential between government and private sector discount rates. Increased grain stockpiling would not lower the rate of general price inflation.

IV. THE COSTS AND EFFECTS OF INCREASED GRAIN STOCKPILING: A REVIEW OF THE ECONOMICS LITERATURE

The approach to grain stock policy suggested in the previous section points to several key economic parameters, knowledge of which would facilitate policymaking. First, it is necessary to estimate the resource cost at which additional stability in grain prices can be achieved, *per unit of stability*, that is, the "price" of grain price stability. This price might be measured by the cost to government of reducing the variance of grain price fluctuations by 1 percent, for example. Economic analysis will not be able to estimate how much price stability government should purchase because this will depend on an evaluation of the externality objectives of increased stockpiling, an evaluation that economic analysis is not suited to perform. Nonetheless, an estimate of the cost-per-unit of grain price stability may enable policymakers to choose the amount of additional stability desired. Unfortunately, existing economic studies do not directly address this subject. There is, however, an economics discussion of the "desirable size of stock," which we review in the first major subsection below. Also, we summarize a forthcoming Rand paper which provides a preliminary estimate of the price of stability.

Second, it would be useful to know the "rate" at which government stockholding can be expected to replace private sector stockholding, that is, the fraction of a bushel by which the private market reduces its stockholdings for every bushel held by government. Once policymakers decide how much price stability to promote and how large a carryover grain stock is required to achieve that level of stability, the question arises of how large a stock would have to be held by government to induce the level of total (government plus private) grain stocks desired. Again, the existing economics literature does not answer this question directly. However, by subsidizing the private sector to hold increased stocks, government can increase total stocks without displacing any private stocks. This issue is discussed in the second major subsection below.

Finally, there is the issue of how any benefits arising from government intervention in grain storage markets are distributed, the cost being borne by taxpayers generally. The distribution of these benefits between producers and consumers will affect political support for and resistance to government stock policy, both domestically and internationally, and if costs of a grain stockpile are to be shared internationally, the distribution of stockpiling benefits among exporting and importing countries may provide a basis for distributing the cost burden. The economics literature discusses the distribution of government grain storage benefits between producers and consumers by drawing on the somewhat related discussion of the welfare effects of profit-motivated price stabilization. The discussion of this topic in the economics literature is summarized in the third major subsection below.

THE DESIRABLE LEVEL OF GOVERNMENT GRAIN STOCKS

There are two basic approaches to determining the desirable level of carryover grain stocks—what might be called the “mechanical” and the “economic.” *The mechanical approach determines the level of grain stocks required to reduce to a specified level the probability that unusually large production shortfalls will cause grain supply and consumption to drop below arbitrarily chosen levels.* The appropriate size of carryover stocks is simply that size required to achieve the government’s presumed goals. This approach has been used by Sharples and Walker¹; Steele²; the FAO³; Bailey, Kutish, and Rojko⁴; Tweeten, Kalbfleisch, and Lu⁵; Reutlinger⁶; Simaika⁷; and Miller.⁸

The economic approach determines the level of carryover grain stocks that equates the marginal expected benefit of storing the last ton of grain to the marginal expected cost. Ideally, this approach would incorporate externality benefits and costs, as well as those reflected in market demand and supply curves. *When only the benefits and costs reflected in demand and supply schedules are incorporated, the economic approach essentially models profit-maximizing behavior and predicts what carryover stock levels private storers can be expected to hold.* To interpret such stock levels as desirable levels for government-held stocks would be to overlook the role of private sector grain stockpiling. The economic approach was first used by Gustafson⁹ in a study done in 1958. More recently, this approach has been used by Danin, Sumner, and Johnson.¹⁰ Their results are also summarized by Hillman, Johnson, and Gray in a study done for the FAO.¹¹

Keeler’s results,¹² in a forthcoming Rand paper written in connection with this report, can be interpreted to provide a preliminary estimate of the price of stabilization. He combines elements of the economic and mechanical approaches by simulating the economic behavior of private storers operating under alternative, mechanically chosen, government storage subsidies.

In their investigations of historical fluctuations in production, estimated costs of storage, and price elasticities of demand, most of the above studies ignore one or both of two private market responses to price variability. *With the exception of the Gustafson and Keeler studies, the above studies ignore profit-motivated accumulation and release of stocks by private storers. Most studies also neglect the price response of planned acreage and production to lagged grain prices.*

¹ “Analysis of Wheat Loan Rates and Target Prices Using a Wheat Reserve Stocks Simulation Model.”

² “The Grain Reserve Issue,” unpublished study quoted in USDA, *The World Food Situation and Prospects to 1985*, p. 43.

³ “World Food Security: Evaluation of World Cereals Stock Situation.”

⁴ *Grain Stocks Issues and Alternatives*.

⁵ *An Economic Analysis of Carryover Policies for the United States Wheat Industry*.

⁶ “A Simulation Model for Evaluating Buffer Stock Programs,” and “World-Wide Buffer Stocks of Wheat.”

⁷ “Probability of Success of a ‘Stock and Allocation’ Policy.”

⁸ “Ways of Balancing the Costs and Benefits of National (or Regional) Stocks.”

⁹ *Carryover Levels for Grains*.

¹⁰ “Determination of Optimal Grain Carryovers.”

¹¹ *Food Reserve Policies*.

¹² “Simulated Costs and Effects of Alternative Wheat Stock Policies.” (forthcoming).

The Mechanical Approach

Let the term "extra stocks" refer to stocks over and above the levels that private storers can be expected to hold for profit-maximizing purposes. If policymakers decide to maintain extra grain stocks, it would be helpful to know the tradeoffs between (1) the average amount of extra stockholding, (2) the cost to government, and (3) the resulting reduction in the variance of grain prices. The mechanical approach may be able to estimate these tradeoffs and thereby the "price" of increased stabilization of grain prices.

Several obstacles to mechanically estimating the cost and effects of extra stockholding need to be indicated. First, without knowing what would be the offsetting effect of government stocks on private stock levels, it is impossible to know the tradeoff between government stocks and price stability.¹³ However, *analysis can attempt to investigate the tradeoff between extra "total" (government plus private sector) stockholding and price stability.*

Second, estimating of the tradeoff between extra stockholding and price stability confronts the issue of substitutability between grain stocks and freer international trade in promoting stability. The Hillman-Johnson-Gray study, to be discussed later, concludes that if all artificial barriers to world trade in grains were eliminated, production fluctuations in various countries would offset each other, and trade would drastically reduce price fluctuations in individual countries to the point at which private storage would seldom be profitable. Thus, the effect of extra stockholding on the freedom of world grain trade, brought about by negotiation or any other means, is crucial in determining how much price stability such reserves provide.

Finally, conclusions based on empirical analysis of historical data, as always, are of limited applicability to present and future situations. The Soviets' recent decision to rely on increased grain imports to offset shortfalls in their domestic production may have increased the variability in U.S. export demand. The recent U.S.-Soviet agreement on grain trade may reduce this variability. The higher price of crude oil since 1972 may have altered supply relationships in grain production. And there are many perhaps less important differences between the present and the past (although analysis can, of course, attempt to take these differences into account).

Despite these obstacles to estimating such tradeoffs as those between extra stockholding, cost, and price stability, some studies have attempted to estimate similar and perhaps related tradeoffs. These studies are briefly reviewed below.

Sharples and Walker, at the USDA and Purdue University, have developed and are experimenting with a simulation model that could be useful for investigating the tradeoffs among expected size of government-owned extra stocks, stabilization of grain prices, and cost to government. We devote particular attention to the Sharples-Walker model on the following pages because its features make simulation studies based on this model the most realistic and, therefore, useful of all studies to date for estimating these tradeoffs. However, the model still has serious limitations, and additional simulation analyses need to be performed, as will be indicated later.

The model, which simulates wheat stock policies for the period 1975-81, incorporates a baseline projection of production, use, and price provided by specialists at USDA. Assumed trends in the demand and the supply schedules cause market price

¹³ This subject is discussed on pp. 12 ff.

to trend downward. Wheat yields and the demand for U.S. exports are allowed to vary around the trend projection. The model contains a linear supply function incorporating a cobweb production response; that is, acreage planted each year responds to the previous year's average wheat price.

The random disturbance term associated with the export demand equation generates most of the market variability in the model. Over the 1962-73 period, the standard deviation of U.S. wheat exports about their mean trend was 6.1 million tons (225 million bushels), but because exports were expected to be more variable over the 1975-81 period, a standard deviation of 8.2 million tons (300 million bushels) was arbitrarily chosen for analysis.

Government is assumed to purchase and stockpile wheat whenever the market price falls to the government loan price, P_L . Government releases wheat from stock, if any exists, when the market price rises to a policy-determined sales price, P_S . Simulations explore the consequences of alternative pairs of P_L and P_S . P_L and P_S , once chosen, are assumed constant over the 1975-81 period.

The size of the government-held reserve is assumed to have no effect on market prices, that is, government stocks do not depress prices by "overhanging" the market. The wheat target price, upon which deficiency payments are based, is also parameterized in the model, but does not influence production decisions. Deficiency payments are investigated by simulation.

Table 7, from Sharples and Walker, summarizes their results from simulating the consequences of using loan rates of \$1.37, \$1.75, \$2.00, \$2.25, and \$2.50 per bushel for the period of 1975-81. The stock release price was arbitrarily set \$1.14 above the loan price in each case.¹⁴

The simulations reported by Sharples and Walker do not explore the possibilities for and consequences of stabilizing grain prices by narrowing the width of the allowed price band. Rather, they explore how the level of the price band can influence price variability. The target price, set for the Sharples-Walker simulations at \$2.50 per bushel in 1975 and adjusted upward in later years, influences government deficiency payments but not demand, supply, price, or government stock levels.

Raising the loan rate increases the frequency and expected quantity of stock accumulation, and hence the degree of price stability CCC stocks provide. As the loan rate is increased, the expected market price increases, and the coefficient of variation of market prices decreases, as shown in Table 7.

Figure 3 shows the expected level of CCC stocks over the 1975-81 period for each loan rate. In each case, expected CCC stock levels increase over time, because market prices trend downward. For example, expected market price trends downward from \$3.62 per bushel in 1975 to \$2.59 per bushel in 1981, assuming that a \$1.37 per bushel loan rate applies. Expected market prices are slightly higher when higher loan rates apply.

When expected market price falls to about the midpoint between P_L and P_S , CCC stocks can be expected to begin accumulating indefinitely.¹⁵ To prevent indefinite

¹⁴ The price spread of \$1.14 per bushel between P_L and P_S was arbitrarily arrived at by allowing government to earn a \$.99 gross profit on each bushel bought at the loan rate and sold the next year at the release price and by assuming a 15 cents per bushel per year physical storage cost. The opportunity cost of storage is neglected.

¹⁵ There is an asymmetry in the accumulation and release of government stocks at P_L and P_S . Government sometimes runs out of stocks and does not sell grain when market price reaches P_S , whereas government always buys grain when market price falls to P_L . As a result of this asymmetry, government

Table 7
 Effect of Raising the Loan Rate on Selected Items Using
 the Wheat Simulator, 1975-81 Average^{a,b}

Item	Loan Rate (\$/bu)				
	\$1.37	\$1.75	\$2.00	\$2.25	\$2.50
Expected Values					
Production (10 ⁶ bu)	2113	2117	2122	2129	2141
Domestic use (10 ⁶ bu)	885	882	880	876	869
Exports (10 ⁶ bu)	1215	1210	1204	1197	1185
Market price (\$/bu)	2.97	3.01	3.04	3.09	3.16
CCC carryout (10 ⁶ bu)	53	96	140	202	293
Government storage cost (10 ⁶ \$)	4	39	84	157	281
Deficiency payments (10 ⁶ \$)	788	629	524	394	232
Total government outlay (10 ⁶ \$)	792	668	608	551	513
Gross income (10 ⁶ \$)	6145	6264	6371	6512	6719
Gross income and de- ficiency payment (10 ⁶ \$)	6933	6893	6895	6906	6951
Coefficient of Variation					
Production	0.11	0.10	0.09	0.08	0.08
Market price	0.43	0.38	0.34	0.30	0.26
Gross income	0.39	0.34	0.31	0.27	0.24
Gross income and de- ficiency payment	0.25	0.24	0.23	0.22	0.21
Frequency (%)					
CCC stocks purchases	16	22	27	33	41
CCC stocks sales	14	17	18	17	14
Deficiency payments	48	44	45	46	45
Zero CCC carryout stocks	76	63	53	43	33

SOURCE: Sharples and Walker, Table 3, p. 25.

^aEach item computed from 2100 observations.

^bTarget price in 1975 is \$2.50.

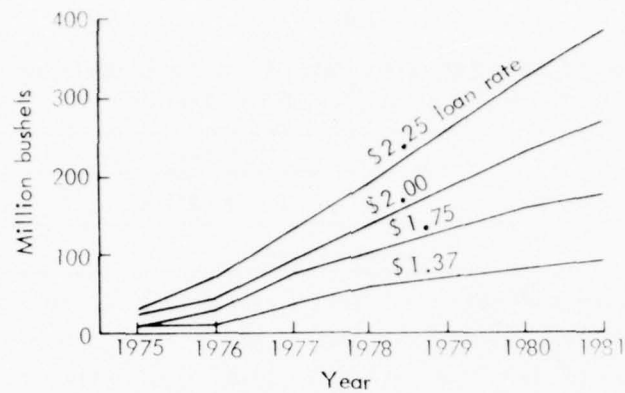


Fig. 3—Expected value of CCC carryout stocks for four levels of loan rates by years, 1975 to 1981

(SOURCE: Sharples and Walker, p. 26)

accumulation once expected market price falls below the midpoint between stock accumulation and release prices, the stock accumulation and release prices would have to be continually lowered.¹⁶

The key limitation of the Sharples-Walker model, *per se*, rather than the simulations explored with it, is that it does not incorporate private sector stockpiling. The analysis by Keeler, to be discussed later, based on the 1979 Sharples and Walker demand and supply curves, suggests that profit-motivated private storage can be expected to produce greater stabilization of wheat prices than even the highest pair of stock accumulation and release pairs (P_1 and P_S) simulated without considering the private sector by Sharples and Walker. In the absence of government stockpiling, prices would be less variable than Sharples and Walker assume. Furthermore, any profitable stockpiling by government would reduce private storage by reducing the opportunity for profitable stockpiling in the private sector. Thus, a bushel of wheat stored by government provides less than a "stored-bushel-equivalent" of price stabilization, because increases in government storage lead to reductions in private storage.

After the Sharples-Walker model has been amended to incorporate private sector storage, future research extending the analysis to cover other grains would be useful, taking into account the interdependence between the various grain markets.

Other limitations of the model are less fundamental. A multiperiod lag structure could be incorporated in the production response of planted acreage to lagged prices.¹⁷ However, prices in the single preceding year are predominantly important, so

stocks would begin to accumulate indefinitely at some point when P_1 and P_S were centered *below* the expected market price, that is, when the expected market price is above $(P_1 + P_S)/2$, assuming the underlying supply and demand fluctuations are symmetrically distributed.

¹⁶ In reality, the CCC need not sell stocks at the release price and the loan rate may be changed from year to year, so the specification deviates somewhat from the way CCC operates.

¹⁷ See Nerlove, *The Dynamics of Supply*.

the assumption of a simple cobweb adjustment of production to the preceding year's price is probably adequate for the present purposes.¹⁸ The model assumes that fluctuations in export demand and domestic production are random-normally distributed, whereas these fluctuations may be to some extent predictable by variables not incorporated in the model. However, it would be difficult to extend the model in this direction because of the complexity of factors causing production and export demand fluctuations.

The policies simulated by Sharples and Walker essentially explore the effects of increasing the support price of wheat (loan rate) on the stabilization of wheat prices (coefficient of variation). As we will show later,¹⁹ the welfare consequences of the price increase in this case are more important than those of the price stabilization. Additional simulations with a revised version of the Sharples-Walker model are needed to determine the cost of stabilizing wheat prices while holding constant the level of price support. Also, since export variability is the primary source of price instability, future simulations should explore the sensitivity of the model to the assumed level of variability in export demand. This level was arbitrarily chosen in the Sharples-Walker model.

Despite the above limitations, Sharples and Walker identify an interesting consequence of the existing principle of using loan and target prices to intervene in grain markets. When the loan rate is raised toward the target price, assuming that market prices sometimes fluctuate low enough for loan and target prices to be operative occasionally, then government increases its average level of loan stocks, as well as the cost of accumulating and storing them, but this cost increase is more than offset by a decrease in the cost of deficiency payments. The deficiency payment on each bushel of wheat is equal to the target price less either the market price or the loan rate, whichever is higher. Thus, raising the loan rate lowers the expected deficiency payment. It appears that a government-held grain reserve can be accumulated at the same time that deficiency payments are reduced and the total cost to government is decreased.

However, this result is misleading. Raising the loan rate raises average market prices, since market prices can be considered to be bounded below by the loan rate. Therefore, the decrease in deficiency payments comes at the expense of an increase in the average food bill of consumers, who will have to pay higher average market prices over the long run. The government's grain reserve is thus paid for by higher grain prices to consumers.

W. Scott Steele at the USDA has calculated the wheat and coarse grain stock levels (for the world, developed countries, LDCs, and centrally planned countries) that would have been needed between 1960 and 1973 to even out shortfall deviations from trend in yield, production, and import demand. He calculates the stock levels

¹⁸ It might be argued that, contrary to the Sharples-Walker model, target price rather than market price should influence production decisions for market prices below the target price because farmers know they will receive at least the target price for their production. Actually, farmers receive the target price for only a portion of the production ("normal production") or their allotted wheat acreage ("pay basis"). When market price falls below the target price, production is generally above normal, so that marginal production would be worth the market rather than the target price. The Sharples-Walker formulation is correct.

¹⁹ See pp. 00-00.

that would have been needed to offset alternatively 68 and 95 percent of the shortfalls.²⁰ Steele's calculations are set forth in Table 8.

However, desirable stock levels cannot be determined from such an analysis because the price responses of consumption and production, which would partially offset any production shortfall, have been ignored. Furthermore, the analysis ignores the role of private storage, which can be expected to stockpile the socially desirable stock levels to handle the remaining shortfall deviations. *The contingency stock levels calculated by this approach can be interpreted only as upper bound estimates of the average stock levels that the private sector can be expected to hold.*

The FAO analyzed trend deviations in production and consumption for the world and for exporting and importing countries from 1955-1972 and concluded that the "minimum safe level" of world stocks for all cereals would fall within a range of 17 to 18 percent of world consumption. Because this analysis neglects production and consumption responses to price changes and does not distinguish between private and government stocks, these levels should be interpreted as upper-bound estimates of the average stock levels that the private market can be expected to hold.

Tweeten, Kalbfleisch, and Lu, at Oklahoma State University, developed a stockpiling simulation model designed to apply to the 1970 structure of the U.S. wheat industry. Their model was a precursor of the Sharples-Walker model, and the Tweeten-Kalbfleisch-Lu parameters were designed to describe the now outdated export demand and supply relationships that existed in 1970. Because these empirical functions are no longer realistic, the latter model is less useful than the former for policymaking purposes.

Some Tweeten-Kalbfleisch-Lu simulations include a demand function for private sector stockpiling and no provision for government stockholding. But this function is not derived from profit-maximizing criteria—rather it is an arbitrarily chosen linear function of price. In other simulations, government buys and sells wheat at arbitrarily chosen price intervention points and accumulates stocks in the process, as in the Sharples-Walker model. Still other simulations take a more "economic approach," in which stock management follows an inventory control algorithm designed to maximize the long-run "social benefit" of stockpiling.

Bailey, Kutish, and Rojko at the USDA simulated a grain stockpiling scheme for meeting world-wide production shortfalls. Unfortunately, because of the simplicity of their model, the empirical results are of little use for estimating the tradeoff between extra grain stockholding in the United States and price stability. They neglect production and consumption responses to price changes, as well as private sector stockpiling. They examine the contribution of their hypothetical stockpiling scheme in terms of data from the 1950-69 period only; no adjustment is made for anticipated differences between these years and the post-1975 period.

Reutlinger,²¹ at the World Bank, has developed a simulation model for analyzing worldwide stockpiling of wheat. The analysis assumes no barriers to international trade in wheat and no shipping costs, so production shortfalls and surpluses in

²⁰ Similar analyses of the contingency stock levels needed to meet shortfall deviations from trend have been done elsewhere in the U.S. Government and exist in unpublished form. We are referring to an anonymous study entitled "Analysis of Alternative Wheat Reserve Policies," including Supplements 1 and 2, circulated in Washington, August 1975.

²¹ "A Simulation Model for Evaluating Buffer Stock Programs" and "World Wide Buffer Stocks of Wheat."

Table 8

**Reserve Stock Levels for Total Grain, Including and Excluding Rice,
and Food Grains Needed to Even Out Shortfall Deviations
from Trends in Production, 1960-73
(In million metric tons)**

Region	95 Percent of ^a Shortfalls Covered	68 Percent of ^a Shortfalls Covered	Maximum ^b Shortfall During 1960-73 Covered
Total grain, excluding rice:			
World	52.5	24.1	31.7
Developed	40.9	18.8	40.6
Developing	6.5	3.0	4.2
Centrally planned	34.6	15.9	29.2
World, excluding exporters	34.9	16.0	32.3
World, excluding exporters and USSR	20.9	9.6	19.2
Total grain, including rice:			
World	56.4	25.9	40.6
Developed	40.9	18.8	40.8
Developing	19.2	8.8	12.6
Centrally planned	35.9	16.5	33.0
World, excluding exporters USSR and India	21.1	9.7	12.5
India	10.0	4.6	7.1
Food grains:			
World	33.6	15.4	25.3
Developing	17.2	7.9	12.9
Excluding India	10.5	4.8	10.4
India	12.2	5.6	7.4

SOURCE: W. Scott Steele, "The Grain Reserve Issue," Economic Research Service, USDA, 1974 (unpublished).

^aThe 95 percent level and the 68 percent level refer to the percent of shortfall deviations from trend that would be covered by the reserve stock levels stated. These reserve stock levels are based on the standard error of estimate of the trend equations and critical t values of 2.179 and 1.000, respectively. The 95 percent level is akin to meeting 19 out of 20 shortfalls and the 68 percent level, 2 out of 3 shortfalls. These percentages refer to the number of shortfalls covered. An alternative way of viewing the issue is to consider what percent of the time that these reserve stock levels will cover the shortfalls. To say that 95 percent of the shortfalls will be covered is equivalent to saying that 97.5 percent of the time, the reserve levels would be adequate to cover any shortfalls that occur. The difference in these two percentages arises from the fact that this analysis has been concerned with only the shortfall deviations from trend. With the assumption that total deviations from trend are normally distributed (which, given the small sample size, is approximated here by a t distribution) the shortfalls would be expected to occur half the time. Thus, for any single year the probability that the indicated reserve stock levels will be adequate to cover any shortfall is 0.975, i.e., 97.5 percent of the time any one-year shortfall will be covered.

Following the same reasoning, to say that 68 percent of the shortfalls will be covered is equivalent to saying that any shortfall that occurs will be covered 84 percent of the time. The probability that in any single year the reserve stock levels will cover any shortfall is 0.84.

^bRefers to the amount of reserve stocks needed to cover the maximum actual shortfall, or in the case of import demand, the maximum above-trend fluctuation, which occurred during 1960-73. It should be noted that the actual maximum shortfall during 1960-73 was, for the world as well as for each region, less than the indicated reserve necessary to cover shortfalls at the 95-percent level. The reason for this difference is that the statistical test used corrects for a theoretical understatement of the shortfalls because of the small sample of years. If the objective for holding reserve stocks is to meet the maximum actual shortfall which occurred during 1960-73, then 40.6 million tons in the case of total grain, including rice, would be held. Rice has been included on an unfilled basis.

various parts of the world can freely offset each other. Storage rules are specified by arbitrarily chosen pairs of stock accumulation and release prices. There is no profit-seeking private storage activity. World-wide production is a function of time and a disturbance term, and the supply response of farmers to shortfalls in production is ignored. The parameters of the demand and supply functions are arbitrarily chosen, and these functions do not reflect actual markets.

Simaika develops a formula for calculating the probability that any given initial world stock level will permit world consumption to be maintained at a specified level under alternative stock accumulation and release rules. The specified consumption level does not vary with prices, and prices play no part in this formula. The costs of storage are not calculated.

Miller examines the technical relationship between the annual, per-ton cost of grain storage and the number of years that grain is expected to be stored.

Although the mechanical approach is capable of yielding an estimate of the price of achieving stability of grain prices by holding extra stocks, no existing studies have focused on this parameter (as we have indicated above in our discussion of each study).

The Economic Approach

Gustafson attempted in a 1958 study to determine the economic value of grain stock programs that stabilize grain consumption. He defines an optimal storage rule that maximizes the net present value of the social benefits from storing grain during above-trend production years for consumption during below-trend production years. Following standard welfare economic criteria, the social value of grain consumption is assumed to be entirely reflected in the market demand schedule for grain.²² Gustafson shows that the optimal storage rule from society's standpoint is to select the level of grain stocks that equates the marginal expected benefit of storing an additional unit of grain to its marginal storage cost. Production variability leads grain stock levels to vary from year to year. This optimal storage rule turns out to be equivalent to the rule that predicts the behavior of profit-maximizing private grain storers, as argued in Section III. This assumes that the private market and government face the same interest cost on capital and place the same discount on future benefits, as discussed earlier.

Using Gustafson's storage rule, Hillman, Johnson, and Gray estimate the size of optimal grain stockpiles under a variety of assumptions about international trade. The Hillman-Johnson-Gray study presents concurrent unpublished work by Danin, Sumner, and Johnson. Assumptions as to the freedom of international trade are important because grain purchases on the world spot market are an alternative to grain storage for sustaining the level of grain consumption during below-trend production years. *In general, the less restrictive the trade barriers, the smaller the level of optimal grain storage in any given country and for the world as a whole.* The results of the Hillman-Johnson-Gray study illustrate this proposition.

As an initial scenario, the study assumes no export or import barriers to free international trade, and consequently that a country always has recourse to spot

²² See the discussion of the welfare effects of storage on p. 14 ff.

grain purchases at the world market price to offset any shortfall in local grain production. Price differentials between countries are determined solely by transportation costs. The study concludes that an optimally managed world grain stock program would accumulate carryover stocks only occasionally, and these in smaller quantities than have been held in recent years by the major grain exporters. World carryover stocks of wheat, rice, and coarse grains would be expected to reach 17 million tons only once a century, and 10 million tons once every twenty years. Reserves greater than zero would be expected to accumulate about once every five years.

As an alternative scenario, the study considers a world where free trade exists within regions or countries but only "normal" trade exists between these regions or countries and the remainder of the world. By assumption, during below-trend production years, grain imports for these regions and countries cannot be expanded above their historical mean levels. The assumed inability to expand grain imports is attributed to trade interferences imposed by exporting countries.

The study considers the following developing countries and regions: India, Pakistan, Bangladesh, the Philippines, Indonesia, other Far East (excluding China, North Vietnam, and North Korea), Africa, Latin America, and the Near East. The study concludes that over time the average optimal level of grain stocks for all of these developing regions together would total 13 million tons. The developed countries are assumed to pursue their own policies to cover their own production shortfalls. Since the 13 million ton average is much larger than the average optimal world stock assuming free trade in grains, it may be concluded that the barriers to international trade explain why the desirable level of world grain stocks is nonnegligible.

However, policymakers should be cautioned against using this 13 million ton figure as an estimate of the needed stock for LDC emergency needs because it overestimates the optimal level of government stocks for such purposes. First, imports are an alternative to holding emergency grain stocks to the extent that imports may in practice be increased in shortfall years (ruled out in the model by assumption). Yield intercorrelations are generally low among the nine developing countries and regions under study, so these regions would be unlikely to have production shortfalls simultaneously. Hillman, Johnson, and Gray suggest that in the actual world, where there is some freedom for individual countries to increase imports during shortfall years, about 7 to 9 million tons of grain could provide approximately the same degree of security as the system of national and regional stocks totaling 13 million tons for a world in which imports could not be increased to meet production shortfalls.

Second, the estimated optimal stock levels should not be interpreted as applying exclusively to government stocks, since the Hillman-Johnson-Gray study models optimal carryover stocks without regard to their distribution between government and private ownership. Because the storage rule used in the study is also the rule that is theorized to govern private sector grain storage, the private market would be expected to store the entire optimal stockpile calculated by Hillman, Johnson, and Gray.

Third, the Hillman-Johnson-Gray study overestimates the optimal level of total grain storage by ignoring the supply response of grain production to the previous year's grain prices. Below-trend production years may be expected to be followed by above-trend production years because the high spot prices in below-trend years

induce farmers to plant more grain in the following year. Within the context of the model, where world production is a function of time and a random disturbance term, the production response of farmers to shortfalls in production appears as a negative serial correlation in the disturbance term. There is reason to believe that this effect may be important.²³ By neglecting negative serial correlation, the study overestimates the optimal level of grain storage.

The Hillman-Johnson-Gray study also examines a hypothetical insurance reserve scheme whereby the developed countries share the burden of storing enough grain stocks to offset all production shortfalls in developing countries that exceed 6 percent below-trend grain production.

It is assumed that the developing countries would continue to stockpile grain although the amount of storage that would be optimal is substantially reduced, since the largest shortfall that must be met is 6 percent of trend production. Again it is assumed that there is no trade among the developing regions and countries and that net imports are not raised to offset fluctuations in production other than the quantities involved in the insurance program.

The study calculates that for production fluctuations over the 1950-73 period, such an insurance scheme would have entailed an average annual shipment of 1.8 million tons of grain from the developed to the developing countries and would have substantially reduced the developing countries' optimal level of reserves. For example, following an optimal stockpiling rule, India's level of grain reserves would have been less than 3 million tons for 50 percent of the years without the insurance scheme. With the insurance scheme, India's optimal grain reserve would have been less than 0.5 million tons for 50 percent of the years.

The insurance scheme represents a mechanical approach to determining grain stock policy. First, prices are not allowed to ration consumption when production falls more than 6 percent below trend. Second, the costs and benefits of the insurance reserve scheme are not calculated, and there is no balancing of the relative costs and benefits of insuring that the grain consumption does not fall below 6 percent of trend production in the developing countries, as opposed to 3 or 9 percent, for example.

The Price of Stabilization

Keeler uses the Sharples-Walker wheat supply and demand schedules and the private sector storage model developed by Gustafson to simulate the costs and effects of subsidizing the private sector to increase carryover stock levels. These simulations provide a preliminary estimate of the price of stabilization.

Following Gustafson, private storers are assumed to store an additional bushel of wheat if the discounted expected marginal value of that bushel in the following year exceeds its marginal cost this year plus the cost of one year's storage. Storage is assumed to cost \$.15 per bushel in physical storage charges plus foregone interest of 8 percent on capital tied up in the stored grain.²⁴ The expected value of an

²³ We calculate, using Reutlinger's data, a -0.6 Pearson correlation coefficient between the current period and the previous period disturbance terms of the regression of world wheat production on the time trend variable, whereas the Hillman-Johnson-Gray analysis implicitly assumes this correlation to be zero.

²⁴ The 8 percent interest rate follows Sharples and Walker's assumption. Preferably, the selected interest rate would reflect the riskiness of grain stock investments.

additional bushel of wheat in the following year depends on the total amount of wheat stored in the present year and on the present year's market price, which influences next year's production. The model is based on the wheat supply and demand schedules for 1979 used by Sharples and Walker. The standard deviations of domestic production and export demand fluctuations are initially the same as those used by Sharples and Walker, but Keeler also examines the sensitivity of the simulation results to changes in the export demand's standard deviation. Each simulation begins with a zero wheat stock.

Keeler's simulation results for a number of alternative policies are presented in Table 9. The first row describes as a baseline scenario a world in which no storage is possible. The following three rows describe private sector storage: operating with no subsidy, and with \$.15 and \$.30 per bushel subsidies on carryover (but not working) stocks, in each case assuming the 300 million bushel standard deviation of export demand used by Sharples and Walker. The next two rows describe private sector storage when export demand is less variable, as indicated, but no storage subsidies are in effect. The final row describes, as an additional baseline scenario, a world in which fluctuations in supply, demand, and price do not exist.

The first two rows of Table 9 show that private sector storage, operating without government subsidies, damps most of the price fluctuations that would exist in a world without storage. Private storage reduces the standard deviation of price fluctuations from \$2.02 per bushel to \$.72 per bushel. *Private storage provides greater price stabilization than any of the government stockpiling policies simulated by Sharples and Walker, in which the role of the private sector is ignored.* The highest loan rate in the Sharples-Walker simulations leads to a coefficient of variation of market price of 0.26,²⁵ which translates to a standard deviation of 0.82, greater than the standard deviation Keeler calculates would result from unsubsidized private storage. The results are not strictly comparable because the Sharples-Walker model applies to the 1975-1981 period, whereas the Keeler model applies only to 1979.

The first and third columns of Table 9 contain Keeler's preliminary estimates of the price of stabilization. To reduce the standard deviation of wheat prices from \$.72 to \$.61 per bushel government can expect to incur subsidy costs of \$34 million per year. To further reduce this standard deviation to \$.44 per bushel, the government can expect to incur additional subsidy cost of \$86 million per year.

But such subsidization policies have a number of other effects that are worth noting. The \$.15 per bushel subsidy fully covers the physical costs of storage so private storers spend only the opportunity cost of capital invested in stored grain. The \$.30 per bushel storage cost almost fully compensates both physical and opportunity costs of storage. A storage subsidy exceeding physical and opportunity storage costs would lead to explosive accumulation of stocks.²⁶

Subsidizing private storage and thereby stabilizing price fluctuations tends to reduce the value of export sales in Keeler's model, because price fluctuations are largely due to fluctuations in export demand, which means that prices are higher when export quantities are greater. Reducing price fluctuations through storage subsidies reduces prices in years when exports are greatest and increases prices when exports are least, with the net result that the value of export sales is decreased.

²⁵ See Table 7, p. 31.

²⁶ In Table 9, subsidy costs exceed average carryover times the storage subsidy because subsidy costs are a discounted average whereas carryover is an undiscounted average.

Table 9

The Cost of Stabilizing U.S. Wheat and the Effect of Reducing the Variability of U.S. Wheat Export Demand: Expected Annual Values for Alternative Policies from an Exemplary Simulation

Policy	Standard Deviation of Market Price (Dollars per bushel)	Average Carryover (Million bushels)	Physical Storage Costs ^a (Million dollars)	Subsidy Costs ^b (Million dollars)	Domestic Consumer Welfare (Million dollars)	Export Sales (Million dollars)	National Welfare ^c (Million dollars)	World Welfare ^d (Million dollars)
No storage	2.02	0	0	0	-136	-416	-526	-408
Private sector storage (export S.D. = 300) ^e	0.72	171	24	0	--	--	--	--
Storage subsidy								
0.15/bushel	0.61	242	34	34	+3	-3	-8	-2
0.30/bushel	0.44	460	60	120	+2	-5	-36	-31
Private sector storage (export S.D. = 225) ^e	0.61	108	15	0	+8	-60	-39	(f)
(export S.D. = 100) ^e	0.40	35	5	0	+25	-136	-90	(f)
Perfect price stability in an idealized world	0	--	--	--	+35	-150	-89	36

(Divergence from Row 2)

^aExcludes the opportunity cost of capital invested in stored grain.^bAssumes working stocks are not subsidized.^cNational welfare is the sum of domestic welfare from consuming U.S. wheat, plus export sales revenue less physical and opportunity costs of storage.^dWorld welfare is the sum of domestic and foreign welfare from consuming U.S. wheat, less physical and opportunity costs of storage.^eThe standard deviation of export demand in millions of bushels.^fWorld welfare depends on how export variability is reduced.

Apparently, to the extent that the United States monopolizes the world's grain storage industry, it would be able, theoretically, to increase domestic welfare at the expense of grain importing countries by reducing the amount of U.S. grain storage and price stability, that is, by increasing price variability. However, grain importing countries would then have an incentive to construct additional storage facilities and take over the reduced U.S. storage role.

Domestic consumer welfare is at first increased as storage subsidies are applied and price fluctuations reduced.²⁷ But, in Keeler's model, storage subsidies increase the rate of initial stock buildup, thereby bidding up the price of wheat while the initial stockpile is being accumulated. Consequently, the \$.15 per bushel subsidy benefits consumers by 3 million dollars per year, but a subsidy of \$.30 per bushel leads to faster and greater stock accumulation which raises market prices with the result that the net benefit to consumers is only \$2 million per year.

National (U.S.) welfare is reduced by storage subsidies because the increased physical and opportunity costs of storage and decreased export sales outweigh the increased consumer welfare. The subsidy costs are an income transfer from taxpayers to storers, and have no welfare implications in this model because distributional considerations are ignored.

World welfare decreases as the storage subsidy is imposed because increased storage costs in the United States outweigh the increase in world benefits from consumption of U.S. grain.

To test the sensitivity of the results to the assumed standard deviation of export demand, two additional policies were simulated, one assuming that export demand fluctuations had a standard deviation of 225 million bushels, its average level between 1962 and 1973, and another assuming an export demand standard deviation of 100 million bushels, as might be produced by trade liberalization or minimum purchase trade agreements coupled with an increase in foreign storage activity. *The resultant standard deviations of market price show that reducing the amplitude of export demand fluctuations by 25 percent to 225 million bushels and by 67 percent to 100 million bushels has effects on the stabilization of grain prices of about the same magnitude as those of storage subsidies of \$.15 and \$.30 per bushel.* However, price stability resulting from stabilizing export fluctuations benefits consumers more than price stability resulting from storage subsidies because the former does not involve a stockpile buildup and an accompanying temporary increase in prices while stocks are accumulating.

Policymakers should recognize the limitations of Keeler's analysis. First, Keeler simulates only one type of storage subsidy scheme, although other storage schemes could be designed to stabilize prices at a lesser cost to government.²⁸ Second, he assumes that 1979 supply and demand conditions prevail indefinitely, neglecting supply and demand trends. Third, he assumes constant physical storage charges, whereas in actuality they vary with supply and demand conditions in the storage industry. Fourth, he attributes the annual price fluctuations to assumed random fluctuations in supply and export demand schedules, whereas these fluctuations may, in fact, be somewhat predictable. Fifth, because stocks are built up from their

²⁷ Producers do not benefit from price stabilization in this model because of the assumption that the short-run supply schedule is perfectly inelastic, see pp. 45-47. The economic concept of "welfare" is discussed on pp. 44ff.

²⁸ See p. 43.

initial zero level, wheat prices rise as they are stabilized. This price shift has welfare implications that are independent of those due to price stabilization, as is discussed later.²⁹ Thus, the analysis does not compare price stabilization options in their long-run steady states. *Further research is needed to refine and extend Keeler's estimates of the price of stabilization.*

THE EFFECT OF GOVERNMENT STOCKS ON PRIVATE STOCKHOLDING

United States grain stock policies envisioned for the future would differ from grain stock policies of the 1960s. In the past, government grain stocks were an inadvertent result, not a desired end, of domestic agricultural programs whose primary purpose was to support and raise the average price of grains. Past government price support programs indirectly provided price stabilization by keeping prices at or above the support levels, but the price-raising effects of these programs were probably more important for consumer and producer welfare than the price stabilization effects.³⁰ Past programs led to an expensive accumulation of government stocks because programs were not designed to periodically release on the commercial market as much stock as they accumulated.

Unlike past programs, future grain stock policies would probably be designed to accumulate and release stocks so as to raise prices during years of bountiful harvest and depress prices during years of lean harvest. Some fear that government grain stocks would "overhang" the market and depress prices. Although government stocks would certainly depress prices in lean harvest years, this would be precisely the government's objective. But we see no reason to believe that grain prices, averaged over lean and bountiful harvest years, would be depressed or raised by a government grain stock program that, over the long run, neither continued to accumulate nor decrease stocks.³¹

We do not have a reliable estimate of the effect of government stockholding on private stock levels, because only since 1972 have government grain stocks been low enough to permit profitable arbitraging of grain between bountiful and lean harvest years by the private sector, and a few more years may be required before we learn how private storers respond to renewed opportunities for profitable storage.

The extent to which government stock policies may be expected to reduce private sector stockpiling depends on whether the government subsidizes the private sector to store grain beyond the levels it otherwise would or buys and sells grain on its own account. If government were to buy and sell grain on its own account (although storage space could be rented from the private sector), the effect of government stocks on private sector stockpiling would depend on whether government stockpiling is profitable or not, and on the amount of government stockpiling.

If the government subsidized private sector grain stockpiling rather than owning grain stocks on government account, private sector stockpiling would be increased,

²⁹ See p. 47.

³⁰ The relative welfare effects of the price support and price stabilization aspects of the policies simulated by Sharples and Walker are discussed on p. 48ff.

³¹ The effects of grain stockpiling and stabilization of prices on their average level could depend on the type of government program. This subject is discussed further on p. 47.

rather than reduced, by government intervention. Private grain storers would elect to store additional grain, and this would provide increased stabilization of grain consumption levels and prices. By adjusting the subsidy, government could adjust the level of total grain stocks and the level of price stabilization.

*The costs and price stabilization effects of a storage subsidy would depend on the type of subsidy used. For example, a stockpiling subsidy for use in abundant harvest years when it was desired to build up stocks could be coupled with a storage tax for use in lean harvest years when it was desired to decrease stocks. The relative costs and effects of alternative storage subsidy schemes should be investigated in future research.*³²

For government-owned stocks, profitability depends on the level and spread of intervention prices selected to govern stock accumulation and release decisions, assuming this is how government chooses to implement its grain stock policy.³³ First, centering this price band increasingly above the average market price leads to increasingly unprofitable storage in the long run. Because of production and consumption responses to the higher average grain prices, stocks are accumulated more frequently and in larger amounts than they are released, and eventually the storage costs of the indefinitely accumulating stock outweigh any profits from stock release sales. Placing the price band increasingly below the average equilibrium price leads to increasingly more frequent release of government stocks, and the government is out of stocks more frequently. Whatever stocks are accumulated can be expected to be profitable, on the average, assuming the price band is wide enough to cover expected storage costs. But such stocks could not provide much security from high prices, because the stocks would be sold often during relatively normal production years before prices had reached their highest levels.

Second, the width of the price band must be neither too narrow nor too wide. The former leads to frequent accumulation and release of stocks, but the price differential between buy and release prices does not cover the expected cost of storage. Alternatively, the latter may lead to long periods between purchase and sales at a price differential that, while large, is insufficient to cover the costs of storing the grain for the long periods between stock acquisition and release.³⁴

If government decides to accumulate stocks on its own account by setting stock accumulation and release prices, further research should be undertaken to examine the costs and effects of alternative levels and widths of the price band.

When government stockpiling is profitable, the government is acting like a private sector storer, whose purchases and sales of grain cover the cost of storage. Because market fluctuations provide a certain limited opportunity for profitable stockpiling, profitable government stockpiling leaves less room for profitable private sector stockpiling. *Profitable government stockpiling can be expected to transfer storage from the private sector to the public sector, bushel for bushel, but not to affect the total level of stockpiling because the government intervention would not influ-*

³² Storage subsidies are discussed further on p. 59 ff.

³³ The following discussion also applies to government storage based on quantity triggers for stock accumulation and release because there is an implicit price band for every pair of quantity triggers and an implicit pair of quantity triggers for every price band.

³⁴ See Miller for a simulation (using the Australian economy) of the relationship between the size of grain stocks, the number of years grain is expected to be held in stock, and the expected cost of storage per ton. For example, the cost of storage is \$34 per ton when grain is expected to be held three years, but \$20 when expected to be held two years.

ence the aggregate opportunity for profitable grain storage. Consequently, profitable government grain storage cannot be expected to increase the stabilization of grain prices.

Unprofitable government stock programs may lead to a partial rather than a full offset of private sector stockpiling. For example, consider unprofitable storage caused by the government's selection of too narrow a price band. If the government failed to accumulate sufficient stocks to keep market prices between stock purchase and sales prices, the private sector could be expected to hold some stocks in anticipation of production shortfalls that could not be offset by the existing government stock. If the government always had sufficient stocks to keep prices between its purchase and sales prices, private storage to offset production shortfalls would vanish because prices would not fluctuate sufficiently to cover the cost of storage. To reduce the private sector stock to zero would require a government stockpile of greater size than the original private sector stockpile under free market conditions, since the narrow price band would not allow prices to ration demand in shortfall years or increase production after shortfall years. Thus, an increase in government stocks reduces private stocks by less than the increase in government stocks, and a one-bushel increase in unprofitable government stocks reduces private stocks by less than one bushel.

Because unprofitable government grain storage increases total (government plus private) grain storage, although by less than the size of the government stock, some increased price stabilization does result.

THE WELFARE EFFECTS OF INCREASED GRAIN STOCKPILING

We showed in Section III that increased grain stockpiling beyond the private-market-determined level can be expected to incur storage costs that exceed the benefits accruing directly to grain producers and consumers, assuming that the grain storage market is competitive. Externality benefits were excluded from that analysis. Nonetheless, the distribution of price stabilization benefits between grain producers and consumers may be examined even though it is recognized that the increase in aggregate benefits will be exceeded by the increased storage costs. This issue is important because it has been suggested that the storage costs of an internationally coordinated stockpiling system might be allocated among consuming countries (grain importing countries) and producing countries (grain exporting countries) according to their shares of the storage benefits.³⁵ We neglect the costs of storage in the following discussion.

After explaining in what sense we use the terms "consumer benefit" and "producer benefit," we discuss the distribution of benefits arising from price stabilization around a constant mean price level. If there is either a rising or declining trend in prices, then the variance of prices should be measured relative to trend. Then we discuss how increased grain storage and price stabilization may bring about or be associated with a shift, unrelated to trend factors, in the mean price level. Such a shift has welfare effects that are separate from those due to price stabilization.

Government grain storage benefits consumers if it increases their "welfare" or

³⁵ For example, see Hillman, Johnson, and Gray, pp. 12-13.

"consumer benefits" from grain consumption. We use these terms to refer to the difference between the maximum amount of money that consumers would be willing to pay for any given level of grain consumption (measured by the area under the grain demand schedule between zero and the actual level of grain consumed) and the value of the next best opportunity foregone in the process of purchasing and consuming grain. An increase in consumer welfare understates the benefit to consumers of redistributing grain from bountiful to lean years to the extent that consumers prefer less variability in grain prices and this preference is not reflected in their grain demand schedule.

Producers gain from government grain storage if such storage raises producer welfare or "producer benefits." Producer benefits are measured by the difference between the producer's gross receipts from selling any given level of grain production and the opportunity cost of such sales. This cost is the value of the highest valued alternative use of the grain, either the expected net value of storing it for sale in a future period when prices are expected to be higher or the foregone opportunity of reallocating the resources used to produce that grain (measured by the costs of production, in turn measured by the area under the grain supply curve between zero and the actual level of grain produced) to the production of nongrain goods. Producer gains from price stabilization created by government grain storage exceed the increase in measured producer welfare to the extent that producers' planning costs for production and investment decisions can be reduced by stabilizing grain prices and this cost savings is not reflected in their grain supply schedule.

Stabilization of Grain Prices Around a Constant Mean Price Level

The theoretical discussion in the economics literature about the distribution of benefits arising from stabilization of prices takes a comparative statics approach, that is, consumer and producer welfare are compared in prestabilization and post-stabilization situations. Storage costs are neglected. In the prestabilization situation, supply and/or demand schedules are variable and no reallocation of supplies over time (storage) is allowed. In the post-stabilization situation, the supply and/or demand schedules are still variable, but quantities have been reallocated costlessly over time in such a manner as to eliminate all price fluctuations.

The welfare effects of price stabilization have been analyzed in the economics literature by Waugh,³⁶ Oi,³⁷ Massell,³⁸ Turnovsky,³⁹ Samuelson⁴⁰, and others. The analyses by Waugh, Oi, and Massell are applicable here. Waugh demonstrated that consumers lose from stabilization of price fluctuations caused by shifts in the supply schedule, while Oi demonstrated that producers lose from stabilization of price fluctuations caused by shifts in the demand schedule. These analyses used consumer

³⁶ "Consumer Aspects of Price Instability."

³⁷ "The Desirability of Price Instability under Perfect Competition."

³⁸ "Price Stabilization and Welfare."

³⁹ "Price Expectations and the Welfare Gains from Price Stabilization."

⁴⁰ "The Consumer Does Benefit from Feasible Price Stability."

and producer surplus accounting and assumed zero storage costs.⁴¹ In such models, profit-motivated storage would automatically eliminate all price fluctuations, but private storage is not incorporated in these models.

Massell synthesized and extended these analyses. His model assumed stochastic linear supply and demand schedules of the form

$$\begin{aligned} S &= \alpha p + u \\ D &= -\beta p + v \end{aligned}$$

where S and D are supply and demand quantities, p is price, and u and v are jointly distributed random variables with means ζ_u and ζ_v , variances σ_{uu} and σ_{vv} , and covariance $\sigma_{uv} = 0$. He demonstrated that price stabilization leads to a net increase in aggregate consumer plus producer welfare, even though either producers or consumers might lose from price stabilization in accord with the Waugh and Oi analyses. Price stabilization is brought about by the introduction of costlier storage. The net welfare gain, assuming prices are perfectly stabilized, is $[(\alpha + \beta)/2]\sigma_{pp}$, where σ_{pp} is the prestabilization variance of prices. Aggregate net welfare gains from price stabilization are proportional to the flatness of the supply and demand schedules and the degree of price variance stabilized.

The benefit accruing to consumers is

$$\frac{(2\alpha + \beta) \sigma_{vv} - \beta \sigma_{uu}}{2(\alpha + \beta)^2}$$

and the benefit accruing to producers is

$$\frac{(\alpha + 2\beta) \sigma_{uu} - \alpha \sigma_{vv}}{2(\alpha + \beta)^2}$$

*The greater σ_{uu} relative to σ_{vv} (i.e., the more that uncertainty comes from the supply side relative to the demand side) the larger the benefit going to producers and the smaller the benefit going to consumers, and vice versa.*⁴² The Waugh and Oi results can be seen to hold for the case in which only the supply schedule or only the demand schedule fluctuates. Then consumers or producers, respectively, lose from price stabilization. Also, the greater α relative to β , the larger the benefit going to consumers relative to that going to producers, and vice versa. *That is, benefits tend to go to market elements with more price-responsive (flatter) demand and supply schedules.* In any given situation these two effects must be considered in determining the distribution of benefits. But the net benefit among consumers and producers is always positive (ignoring storage costs), so conceptually the gainers can compensate the losers and leave everyone better off after stabilization.

If profit-motivated storage were introduced into this model, it would perfectly stabilize prices, since storage costs are zero, including the opportunity cost of stored grain. (The discount rate is also zero.) This result requires that storers know the long run expected price. Thus the above analysis of welfare benefits refers to benefits

⁴¹ To the extent that risk averseness is present, consumer and producer surplus analysis understates stabilization benefits. Also, since price fluctuations in one market can have nonnegligible effects on real income and demand in other markets if expenditures in the first market are large enough, the welfare analysis in the first market should use general rather than partial equilibrium (income-compensated) demand schedules.

⁴² See Massell, pp. 292-293.

achieved by introducing profit-motivated storage, leaving aside the cost of such storage.

For policy purposes, we are interested in the welfare effects of marginal price stabilization introduced by government when storage costs are positive and when private storers already provide profit-maximizing storage, a situation slightly different from the one above. The aggregate net benefit to consumers and producers can now be shown to be $[(\alpha + \beta)/2]\Delta\sigma_{pp}$, where $\Delta\sigma_{pp}$ is the reduction in price variance caused by stabilization policy. The welfare effects of storage costs and government storage subsidies are still not taken into account by this formula, and must be considered separately. Price stabilization creates the largest net increase in consumer and producer welfare, per unit of price variance eliminated, in markets where supply and demand are relatively responsive to price changes. In the case of both food grains (wheat and rice) and feed grains (coarse grains), short-run schedules are inelastic; these are relevant since variation in short-run prices is the concern, long-run supply being influenced by long-run expected price, which does not vary much. But the demand for feed grains is probably more elastic than that for food grains because grazing can substitute for feed grains, meat products can be replaced by other foods, and meat has a relatively high income elasticity, whereas food grains have no good substitute and their demand is income-inelastic.

If, as assumed above for the U.S. wheat market, price fluctuations are caused primarily by fluctuations in the export demand schedule (and to a lesser extent by production fluctuations), but not by fluctuations in the domestic demand schedule, then price stabilization will benefit foreign consumers most, benefit to a lesser (possibly negative) extent domestic producers, but leave domestic consumers worse off. This comparatively large gain accruing to foreign consumers accords with the earlier simulation results. But that welfare analysis is not identical to the theoretical analysis here because the simulations incorporate effects caused by the initial build-up of stocks and the consequent increase in average price, a subject to which we turn next.

A Shift in the Mean Price Level

Stabilization of grain prices may be associated with a change in the average level of prices to the benefit or detriment of consumers. In the long run, this could be expected to affect the quantity of resources devoted to grain production, which would in turn lead to a full or partial offsetting change in the initial increase or decrease in average grain prices.

The analyses by Gray⁴³ and Hillman, Johnson, and Gray involve a decrease in the average level of grain prices which leads to the conclusion that consumers benefit and producers lose from increased stabilization of grain prices.⁴⁴ *Because they assume that the demand schedule is more inelastic at higher price levels than at lower price levels, average price falls when prices are stabilized. Average prices fall*

⁴³ "Grain Reserves Issues."

⁴⁴ Their analysis neglects the impact of reducing the variance in prices on consumer and producer welfare.

not because stocks overhang the market, but rather because price stabilization brings about a price decrease.

Their assumption that demand is more inelastic at higher than at lower prices is based on observations of two arc elasticities of the demand schedule for corn futures, observed four years apart. *In our opinion, this analysis should not form the basis for policy.* Comparing December futures prices on the Chicago futures market for corn with changes in the prevailing estimate of the year's corn crop, the authors found that the arc elasticity of the demand schedule was $-.55$ in 1970 at an average futures price of \$1.40 per bushel, while it was $-.23$ in 1974 at an average futures price of \$3.00 per bushel.

In 1970 the U.S. Government held 543 million bushels of corn under loan to or owned by the CCC at the close of the marketing year on September 30, and the total U.S. carryover stock was 1005 million bushels, whereas in 1974 the government held only 8 million bushels and the total carryover stock was only 483 million bushels.⁴⁵ *The lower stock level alone may explain why futures prices were more sensitive to crop forecasts in 1974 than they were in 1970.*⁴⁶ The use of crop forecasts as a proxy for the supply of grain in a future period may also be open to question. We believe that the evidence is insufficient to demonstrate that the demand schedule for all grains is more inelastic at higher than at lower prices, and that as a consequence increased grain storage and price stabilization would lower average price levels to the benefit of consumers and detriment of producers.⁴⁷

The Sharples-Walker simulations also explore the consequences of a grain price stabilization policy that is mechanically coupled with a change in the average level of grain prices. In contrast to the Gray analysis and that of Hillman, Johnson, and Gray, Sharples and Walker associate price stabilization with an *increase* in the average level of grain prices. They examine the price stabilization effects of raising the price band governing stock accumulation and release and thus raising the average grain price to consumers' detriment and producers' benefit. However, the increased production that would be called forth by this price increase would exert pressure for prices to fall.

When the loan rate is increased from \$1.37 to \$1.75 per bushel in the Sharples-Walker model, the net increase in aggregate U.S. plus foreign consumer and producer welfare arising from price stabilization is \$38.5 million per year, while the increase in average price redistributes \$35.3 million from U.S. consumers to U.S. producers and \$48.4 million from foreign consumers to U.S. producers. When the loan rate is increased from \$2.25 to \$2.50 per bushel, the net aggregate welfare benefits from price stabilization equal \$23.6 million per year, while the increase in average price redistributes \$60.8 million from U.S. consumers to U.S. producers and

⁴⁵ *Commodity Yearbook 1975*, p. 125.

⁴⁶ A regression analysis by Gardner, "Price Response of Grain and Livestock Futures to Crop Production Estimates," supports this explanation. He examines the interaction between stock levels and 14 arc elasticities on the demand schedule for corn futures over the period 1960-1975 (similar to the arc elasticities calculated by Gray and Hillman, Johnson, and Gray) and estimates that on the average the demand elasticity was $-.53$ when stock levels were at about 1 billion bushels and $-.30$ when stock levels were at about 300 million bushels. The change in stock levels between 1970 and 1974 would almost entirely account for the change in demand elasticities observed by Gray and by Hillman, Johnson, and Gray.

⁴⁷ Gray and Hillman, Johnson, and Gray draw the further conclusion on the basis of the analysis above that grain importing countries should pay the largest share of the storage costs of increased grain stockpiling.

\$83.0 million from foreign consumers to U.S. producers. Thus, for the policies simulated by Sharples and Walker, the increase in average prices leads to greater welfare effects than does the stabilization of prices. The cost of government programs to taxpayers is not incorporated here (see Table 10).

The consumer's and producer's benefits from changes in the mean level of grain prices accompanying price stabilization will depend in the short run on the type of price stabilization policy chosen. These welfare effects will be separate and additional to, and may be greater than, the welfare effects resulting from reduction of price variance.

Summary of Welfare Effects

The several welfare effects of increased grain stockpiling beyond the private-market-determined level must be considered simultaneously. First, the storage costs of increased grain stockpiling and price stabilization can be expected to exceed the total consumer and producer benefits from price stabilization, excluding externality benefits. Second, neglecting storage costs, the net aggregate benefits of increased price stabilization will be proportional to the decrease in price variance and to the sum of the price responsiveness of the general equilibrium demand and supply schedules. Third, those benefits will accrue relatively more in supply or demand sectors where the price uncertainty originates and where supply or demand is relatively price-responsive. Thus, most benefits are likely to accrue to foreign consumers, less to U.S. producers, and least to U.S. consumers. This result assumes that most of the market uncertainty arises in the U.S. export demand schedule, with some arising in a U.S. supply schedule that is not perfectly inelastic. The benefits are likely to be greater, per unit of price variance reduced, for feed grains than for food grains, because feed grain demand and supply are relatively price-responsive. Fourth, storage and price stabilization increased beyond the levels provided by the private market may be associated with an increase (or decrease) in the average level of grain prices, and this change would involve a transfer of resources from consumers (producers) to producers (consumers) with welfare effects separate from, and possibly more important than, those due to the reduction in price variance.

Table 10
 Consumer and Producer Annual Gross Benefits from
 Stabilization of Wheat Prices Produced by
 Raising the Loan Rate

	Loan Rate				
	\$1.37	\$1.75	\$2.00	\$2.25	\$2.50
Standard deviation of market price, ^a 1975-81	1.25	1.14	1.03	0.93	0.82
Average wheat price ^a 1975-81 (dollars)	2.97	3.01	3.04	3.09	3.16
	Increase in Loan Rate				
	1.37 to 1.75	1.75 to 2.00	2.00 to 2.25	2.25 to 2.50	
Additional domestic consumer benefit from additional price stabilization (\$ million)	13.08	9.96	8.18	8.03	
Additional foreign consumer benefit from additional price stabilization (\$ million)	25.38	19.32	15.87	15.58	
Redistribution of income from domestic consumers to U.S. producers (\$ million) ^b	35.28	26.40	43.80	60.83	
Redistribution of income from foreign consumers to U.S. producers (\$ million) ^b	48.40	36.12	59.85	82.95	

^a Coefficient of variation of market price times average market price, from Table 7.

^b This estimate is the product of the increase in average wheat price and the average level of wheat consumption for each loan rate. See Table 7.

V. U.S. INTERNATIONAL AND DOMESTIC POLITICAL POSITIONS

Economic analysis may be able to estimate the *price* at which government may purchase stability of grain prices (above the level provided by the private market), but policymakers will still have to decide *how much* price stability to buy. The desirable amount of government-induced additional stockpiling and price stability will depend not only on which government objectives stockpiling and price stability promote but also on how *effectively* they promote them. The expected reactions of various political forces to government-induced increases in grain storage and the stability of grain prices may affect the usefulness of grain storage for achieving diplomatic objectives—for example, European concessions at the Geneva multilateral trade negotiations. Because we lack any specialized training or knowledge in noneconomic matters, this section merely offers our observations, based on what we have read and heard, about a number of noneconomic factors that may influence the effectiveness of grain stock policies in achieving diplomatic objectives.¹

The relevance of arguments which justify intervention by the U.S. Government in private sector storage on the grounds of anticipated achievement of international diplomatic objectives depends on the importance of stabilization to grain importing countries. If a foreign country is indifferent to U.S. stock policies or opposes U.S. objectives, that country may not cooperate in achieving the objectives. To the extent that noncooperation can be expected, the international diplomatic arguments for increased U.S. grain stocks become less persuasive.

Domestically, to the extent that government intervention in grain stock policies is designed to ameliorate dissatisfaction among farmers, consumers, and other domestic groups affected by price fluctuations, it is relevant to consider the positions of these groups.

INTERNATIONAL CONSIDERATIONS

We begin by reviewing briefly the relationships between other countries' domestic and foreign agricultural policies and exploring how these relationships have confounded past rounds of General Agreement on Tariffs and Trade (GATT) negotiations for freer agricultural trade.

The farm policies of the EC, North America, and Japan appear remarkably alike in their objective to support farm income, and in their use of a wide range of direct subsidies and price supports to achieve that objective. Existing trade interferences were apparently adopted, not for their direct benefit, but rather to enable domestic farm policy to function. An international grain reserves agreement could help

¹ A fuller discussion of problems and issues in world agricultural trade can be found in Johnson, *World Agriculture in Disarray* and "Soviet Agriculture and World Trade in Farm Products"; Fried et al., *Toward the Integration of World Agriculture*; de Vries and Richter-Altschaffer, *World Food Crisis and Agricultural Trade Problems*; and Schoonover, "The Soviet Feed-Livestock Economy."

achieve trade liberalization in agricultural goods only if the agreement led to an abandonment of some domestic farm income and price support policies.

European farmers are particularly opposed to freer trade, because it would destroy the economic rents generated by their countries' domestic agricultural policies. Analyses in the late 1960s indicated that the CAP was costing European taxpayers and consumers nearly \$15 billion annually, much of which was transferred directly to European farmers.² United States agricultural programs cost taxpayers \$6.2 billion in 1968, and Japanese agricultural programs cost taxpayers \$2.1 billion in 1968—much of which went to support the price of rice.³ The higher food cost to consumers should be added to these totals to derive the total contribution of agricultural programs to farm income. Governments appear willing to impose large costs on consumers and taxpayers to provide gains to farmers.⁴

The importance of sovereignty over agricultural trade policy was illustrated during the Kennedy Round of GATT negotiations in 1963-67. In response to U.S. agricultural interests, which pressed for trade liberalization to expand farm exports, the United States committed itself to reducing trade barriers on agricultural products. However, the U.S. initiative failed because of EC opposition, which was so strong that it was not dislodged by U.S. threats to delay signing of the agreement governing the trade of all nonagricultural products.

Proponents of U.S. grain stock policy to further the U.S. objective of liberalizing trade anticipate that present attempts to change the agricultural policies of other countries will be successful even though past attempts failed. The admission of the United Kingdom to the EC, putting the large British market behind the highly protected CAP, will reduce the cost of the CAP in continental countries, and probably harden the CAP. However, Britain's entry into the EC will reduce the export market for agricultural products from Argentina, Australia, Canada, New Zealand, and the United States, thereby increasing the pressure from these countries for liberalization of agricultural trade.

Below, we comment on various political factors in Europe, LDCs, the Soviet Union, Japan, and the United States.

Europe

Conceivably, one could argue that by threatening to allow instability to develop in world grain markets the United States might be able to induce the Europeans to institute acreage allotments to control surplus grain production or a stockpile system to absorb it. However, the European resolve to protect the economic rents generated by the CAP would make it difficult for the United States to do so, in our opinion. First, proponents of the CAP support the large income transfers to the farming sector as the well-justified cost of providing European consumers with more price stability than exists on world markets. If the United States were to further

² Krauer and Bernston, "Cost of the Common Agricultural Policy to the European Community," estimated this cost at \$14.4 billion in 1966-67, and Bergman et al., *A Future for European Agriculture*, estimated it at \$12.14 billion in 1967-68.

³ Johnson, *World Agriculture in Disarray*, p. 50.

⁴ Insofar as farm sector benefits from protection have been capitalized in land values, a significant lowering of protection would have its greatest effect on land values and land use. See Johnson, *Farm Commodity Programs*, pp. 51-72.

destabilize world markets, this might harden the position of the proponents of the CAP. Second, the CAP uses its variable levy to insulate EC grain prices from fluctuations in world market prices. Consequently, instability in world markets will influence primarily the EC's tariff revenues, but not EC domestic grain markets. Third, the prices of U.S. exports would not be fully stabilized by increased U.S. grain stocks. After all, the CAP was instituted in 1962 during a period of abundant U.S. grain stocks and reliable U.S. exports.

Even if U.S. grain stock policy cannot influence the CAP, it might be argued that the EC can be induced to share in the cost of an enlarged U.S. stockpile. But such an arrangement would amount to European subsidy of price stability outside the EC as well as inside, and this arrangement could probably be made acceptable to the Europeans only by linking it to nongrain issues.

Less Developed Countries

The LDCs' interest in U.S. grain stock policy derives from their being net importers of grain and recipients of food aid. In 1970, 1971, and 1972, more than 30 percent of their grain imports from the rest of the world were subsidized by the food aid programs of the industrialized countries. The subsidized share of such imports dropped to 23 and 11 percent in 1973 and 1974.⁵

Increased U.S. grain stockpiling would benefit LDCs to the extent that this would stabilize world grain prices and increase food aid shipments. Stably priced world grain supplies would be more "secure" to importing countries in the sense that price stability reduces the risk of high prices in exporting countries leading to export controls. Sometimes it is argued that stability in world commodity prices would spur development efforts. But a rigorous analysis of this hypothesis by MacBean rejects it.⁶ Although these benefits may be important, grain stock issues by themselves are relatively minor elements of the general LDC goal of redistributing wealth from the rich to the poor countries. Most LDCs have the option of engaging in their own stockpiling for stabilization purposes, although climate makes grain storage expensive in many tropical countries and grain stockpiling may not be the most productive use of scarce resources. Of course, LDCs would benefit from additional stockpiling if other countries paid the storage costs.

It might be argued that if the United States would act "responsibly" with respect to its agricultural exports, the LDCs could be expected to act responsibly with respect to their raw material exports. However, in our opinion, the LDCs can be expected to try to organize their raw material exports for greater income regardless of U.S. grain stock policies. The advantages of cartelization, recently demonstrated by oil exporting countries, are probably too inviting to be deterred by U.S. willingness to subsidize the LDCs' grain consumption through an unprofitable grain stock program. Consequently, we believe that U.S. stock policies should not be founded on

⁵ USDA, *World Agricultural Situation*, WAS-6, December 1974.

⁶ Studying how the stability of export proceeds, import expenditures, and export and import prices influenced the growth rates of investment and per capita income between 1946 and 1960, MacBean concluded that "almost every chain of reasoning leading to the conclusion that serious damage is inflicted by instability has been found wanting when confronted with UN and IMF data." MacBean, *Export Instability and Economic Development*, p. 127.

a general hope that the United States will benefit by dissuading LDCs that export raw materials from using whatever bargaining position they may have.

The Soviet Union⁷

Agriculture is a major problem area for the Soviet economy, characterized by high cost and instability. Output is subject to major fluctuations, resulting from use of lands that are vulnerable to wide climatic variations and from technological problems of planting and harvesting. Grain exports and imports represent a residual between the quantities demanded and produced, and thus trade is more variable in percentage terms than production.

The Soviet Union could manage its production and trade instability by stockpiling, but, according to one analysis,⁸ the pressure each year to reach or exceed planned objectives for livestock production results in a continuous failure to accumulate a grain stockpile. This policy could be changing; Bush⁹ reports Soviet plans to construct additional elevator facilities between 1975 and 1980. However, it is not clear whether the additional capacity would supplement or replace existing grain storage facilities, most of which are less efficient grain warehouses that could be converted to nongrain storage. But since so little is known in the United States about Soviet decisionmaking, much of what is written in this regard is largely speculative.¹⁰

It is not obvious whether Soviet grain imports will become a stabilizing or destabilizing force in world markets. The recent Soviet agreement to import minimum quantities of U.S. grain each year through 1980 may only marginally alter the pattern of Soviet imports from what it would otherwise have been. If fluctuations in Soviet grain imports cause parallel fluctuations in world grain prices, then Soviet purchases destabilize world prices. By contrast, if the Soviet Union stockpiles imported grain when world prices are low for later use, then Soviet purchases could help stabilize world prices.

If Soviet grain purchases are destabilizing rather than stabilizing, the Soviet Union would benefit from increased price stability brought about by increased grain stockpiling in the United States. However, it is unclear whether the Soviet Union would value these benefits enough to offer concessions to Western countries in return. Even threatening to embargo the Soviet Union from world grain markets in times of production shortfall would be unlikely to produce Soviet cooperation, unless such an embargo could be enforced, which might be difficult. In any case, the Soviet Union cannot be expected to grant concessions worth more than the cost of doing their own stockpiling.

⁷ See Johnson, "Soviet Agriculture and World Trade in Farm Products," and Schoonover.

⁸ Johnson, *Ibid.*, p. 45.

⁹ "The USSR's Third Major Grain Purchase."

¹⁰ Nikita Khrushchev and other Soviet officials in the past have suggested that the Soviet grain stock should cover between a half and a full year's annual grain requirements, according to an unclassified CIA report, "The Soviet Grain Balance, 1960-73." The report assumes that Soviet grain stocks were 100 million tons in 1972 and increased to between 132 and 147 million tons in 1973. Soviet grain consumption reached 200 million tons in 1973.

Japan ¹¹

One of the primary objectives of current Japanese agricultural policy is to raise the level of national self-sufficiency in food supplies. Japan imports more than 95 percent of its wheat and coarse grain consumption, although it is essentially self-sufficient in rice.¹² Now that U.S. government grain stocks are no longer readily available at a fixed price, the Japanese are investing in storage facilities and buying more grain imports ahead. Japan also intends to diversify and secure its grain import sources by encouraging new or expanded production in certain foreign countries and by arranging long-term (1 to 3 years) supply agreements.

Japanese feed manufacturers may be required by law to build up their working stocks of feed grains over the next few years from about one month's supply to two. At current levels of consumption this would imply an increase in stocks of nearly 1 million tons of feed grain. Some new storage facilities may be located in supplier countries.

The Japanese would benefit from increased U.S. grain stockpiling if this guaranteed Japanese access to U.S. wheat and coarse grain supplies or stabilized world grain prices. It is unclear what concessions the Japanese would offer to the United States in return for increased U.S. grain stockpiling. The Japanese could offer to reduce tariff and nontariff barriers to U.S. imports on a wide range of nongrain agricultural products. They could also offer potentially valuable reductions in their subsidy protection of rice production, but this would require them to abandon their domestic rice policy.

The Japanese can always increase their stockpiling activity if the United States does not.

The United States

Consideration of the perspectives of other countries suggests two fundamental problems confronting U.S. use of grain stockpiling to achieve international trade objectives. First, the agricultural trade policies of other countries are an integral part of their domestic agricultural policies and are defended by strong farm interests. Second, most of these countries are not entirely dependent on the United States to stockpile grain, since they can invest in new storage facilities and expand their own stockpiling, if stockpiling becomes the most productive use of scarce resources. Consider, for example, the U.S. desire to share with other countries the cost of a grain stockpile designed to provide price stability and to facilitate aid shipments to LDCs. Other countries may be willing to bear a portion of such stockpiling costs, but only if they value the resulting price stability and aid programs more than their share of the stockpiling costs.

We can only conjecture about the ability of the United States to use stockpiling to promote international trade objectives. But it is clear that such an approach would incur formidable difficulties.

¹¹ See USDA, "Special Issue: Trends in Japan's Farm Market."

¹² USDA, *World Agricultural Situation*, WAS 7, June 1975. Japanese self-sufficiency in rice is a consequence of large domestic price supports coupled with barriers to the importation of foreign rice.

UNITED STATES DOMESTIC CONSIDERATIONS¹³

In the United States, the major economic interest groups affected by stock policies are grain farmers, consumers, livestock producers, exporters, stors, taxpayers, and humanitarian interest groups. *U.S. grain stock policy cannot further all domestic groups' objectives simultaneously, because these groups possess conflicting goals.* The degree to which stabilizing grain prices will benefit various grain consuming and producing groups will depend on the slopes of their respective grain demand and grain supply schedules and on whether the price stabilization policy raises or lowers average grain prices.

It is important to bear in mind that some of the factors that have led to high grain prices since 1973 would not be ameliorated in the future by stockpiling. Increases in grain prices due to devaluation of the dollar, worldwide inflation, and higher relative prices for production inputs, for instance, would not be reversed by stock policies.

Farmers

As discussed in Section IV, grain producers benefit from stabilization of grain prices proportionally to the price responsiveness of their short-run supply schedule, assuming average prices remain unchanged. Since grain supply is highly inelastic in the short run (although probably not completely inelastic as assumed cobweb production models), this benefit would not be substantial. By contrast, an increase or decrease in the mean price level could benefit or harm producers substantially. The expected change in the mean price level would depend on the type of stabilization policy chosen, although price stabilization need not affect the mean price level in the long run. Average prices, and therefore farmer benefits, would rise if price stabilization were coupled with increased price supports, for example.

Consumers

Consumers benefit from stabilization of grain prices proportionally to the price responsiveness of their grain demand schedule, assuming that mean prices remain unchanged. Given estimates of the price variance and slope of the aggregate consumer demand curve for each type of grain, the consumer benefits from stabilizing the price of each type of grain could be calculated.

For the case of wheat, the Sharples-Walker demand schedule suggests (as shown in Table 10) that the benefits to domestic wheat consumers (including any livestock producers who use wheat) of an 11 percent reduction in the standard deviation of wheat prices (from 1.28 to 1.14) would be 13.08 million per year. Similar calculations for other grain crops and for other hypothetical reductions in the variance of market prices would be useful.

Whether mean prices rise, fall, or remain unchanged would have a separate

¹³ A brief discussion of the economic effects of grain stock policies on various sectors of domestic U.S. markets can be found in Rojko, "The Economics of Possible Food Reserve Systems and Their Relation to Possible Markets."

effect on consumer welfare. This price change could depend on the type of price stabilization policy chosen.

Livestock Producers

Livestock producers primarily consume feed grains, so they would benefit from stabilization of feed grain prices in proportion to the price responsiveness of their grain demand schedule. Because this demand schedule is thought to be relatively flat, livestock producers would benefit more than other consumers from price stabilization, assuming that average prices remained unchanged. It would be useful to calculate the benefits accruing to the livestock sector from stabilization of feed grain prices, once the slope of the livestock sector's demand schedule for feed grains were given. Like other grain consumers, livestock producers are affected by the average price of feed grain that accompanies price stabilization.

Exporters

To the extent that increased grain stocks resulting from domestic price support programs lead to the subsidization of exports, such increased stockpiling would benefit exporters. Further, to the extent that stably priced grain supplies increase U.S. export demand, increased stocks would benefit export interests.

Grain stockpiling may influence trade liberalization and food aid shipments, as discussed previously, and these factors would affect exporters. Trade liberalization could be beneficial or detrimental to exporters, depending on whether it led to an increase or decrease in export prices.¹⁴

Storers

Storers could benefit or lose from stabilization of grain prices depending on the nature of government intervention in grain markets. Storers would lose from government ownership of stocks, because government storage would reduce the opportunities for profitable private storage. Alternatively, subsidizing private sector storage costs would increase the profitability of private storage and expand the size of the storage industry.

¹⁴ According to an estimate by Johnson, abolishing tariffs and export subsidies in world trade in wheat and feed grains would probably not raise world wheat and feed grain prices by more than 10 percent, and it might lower prices by that amount (*World Agriculture in Disarray*, pp. 138-142). We calculate the elasticity of U.S. wheat export supply to be roughly 0.45, based on U.S. production and domestic demand elasticities taken from Cook, *Methodologies for Forecasting Food Supply and Demand*, and 1974/75 U.S. production consumption and export data taken from USDA, *Foreign Agriculture Circular*, April 16, 1975. Further research could improve this estimate. Based on the above information, if trade liberalization increased the world price of wheat by 10 percent, U.S. wheat export earnings would increase by 14.5 percent. This can be considered an upper bound on the export benefits of liberalizing world wheat trade, since world prices might decrease rather than increase.

Taxpayers

Assuming that grain markets are competitive, a government-induced increase in grain stocks could be expected to cost taxpayers more than it would provide them in direct benefits as grain consumers and producers. Externality benefits would have to be considered separately. The taxpayer cost of a storage subsidy program would depend on the size and type of subsidy, and therefore the amount of price stabilization purchased. Stockholding by government may be disadvantageous if it competes for scarce tax funds with other government services, which cannot be met so easily by the private sector.

Humanitarian Interests

Humanitarian interests, which support grain stockpiling for emergency relief purposes, essentially favor the aid element of grain stockpiling. The alternative aid policies should also be considered in this regard.

Summary of Domestic Considerations

Assuming that stabilizing grain prices does not alter average grain prices, such stabilization would benefit grain producers and consumers, including the livestock sector, in proportion to the price responsiveness of their respective short-run, general equilibrium grain demand and supply schedules. To the extent that mean grain prices are raised or lowered by a particular price stabilization policy, this would have a separate and possibly more substantial effect on consumer and producer benefits than the price stabilization per se. Taxpayers absorb the increased storage cost of price stabilization programs; if externality benefits are excluded, then this taxpayer cost can be expected to exceed the sum of the benefits directly received by grain consumers and producers, as argued throughout this report. Exporters would benefit or lose from increased U.S. grain stockpiling depending on whether this led to export subsidies, trade liberalization, or an increase or decrease in grain export prices. Meanwhile, the effect of government policy on grain storers would depend on how the government chose to increase grain stock levels. Humanitarian interests benefit or lose from increased grain stockpiling according to its effect on food aid contributions.

VI. PROBLEMS OF IMPLEMENTATION: THE STRUCTURE OF AN INTERNATIONAL AGREEMENT AND THE NATURE OF U.S. GOVERNMENT INTERVENTION

Should international coordination of reserve stock policies be negotiated at the Multilateral Trade Negotiations in Geneva, where it could be coupled with economically unrelated aspects of tariff reduction, supply access guarantees, and reduction of nontariff trade barriers? Or should it be negotiated at the International Wheat Council in London, where the Soviets are represented but the discussion is confined solely to grain issues? Should U.S. grain stock policy be settled during an election year or postponed for the 1976 Administration? How should Congress and the Administration share responsibility for grain stock policy? How should the interests of consumers and the Departments of Agriculture and State be balanced in formulating policy? Should a formal international agency be formed to administer and coordinate nationally held stocks? If so, what should be its bureaucratic organization and procedures? Although these implementation issues are important, they are beyond the scope of this report.

Nonetheless, in this section we comment on two problems of implementing a grain stock policy that involve economic as well as political considerations. First, should the U.S. Government own stocks or should it increase privately owned stocks by subsidization? Second, how "tightly" should the United States commit its own grain stock policy in an international agreement?

GOVERNMENT OWNERSHIP OF GRAIN STOCKS VERSUS SUBSIDIZATION OF PRIVATE STORAGE

Supposing it has been decided that grain stock levels in the United States will be raised above their private-market-determined levels, then a choice arises between accumulating government-owned stocks and subsidizing the private sector to accumulate larger stocks. We view that choice as independent of how much total U.S. stock levels are to be increased and whether the United States unilaterally decides to raise stock levels or does so in conjunction with an international agreement.

The choice between government ownership and subsidization might influence the contribution of grain stocks to achieving the objectives of grain stock policy. It might be argued that for political reasons government ownership of stocks represents a more visible government commitment to price stabilization than subsidization of private storage, and a more visible commitment would more effectively placate domestic and international political forces favoring stabilization of grain prices or other results of larger stocks. An increase in food aid shipments might result from government ownership of stocks more readily than it would from increased stockholding by the private sector.

But more government resources may be required to achieve a desired degree of stability by using a government-owned stockpile than by subsidizing. First, when

government accumulates stocks, the private sector tends to reduce its stocks (as discussed in Section IV). Consequently, to raise total stocks by 1 million tons, for instance, government would probably have to accumulate more than 1 million tons of grain. Government might have to take over much of the storage function of the private sector before it raised total stock levels significantly. Second, private market control of stock accumulation and release can be expected to be more effective in stabilizing prices than the accumulation and release rules that government would be likely to follow. The private market adjusts stock accumulation and release quickly and flexibly to changing events in the grain markets, the government probably less so. Government would probably choose stock accumulation and release prices or target stock levels that could be changed only periodically.

McKinnon and Houthakker have each suggested that the U.S. Government buy and sell grain futures contracts in such a way as to partially stabilize futures prices, allowing market forces to stabilize cash grain prices in response.¹ Such a scheme would encourage private storage while government is building up a long position in grain futures when futures prices are relatively low and would discourage private storage while government is liquidating a long position in grain futures when futures prices are relatively high. The authors elaborate in their separate papers the details of such a scheme.

The U.S. Government could subsidize any of a variety of private storage costs so as to raise stock levels and increase price stability. Storage costs consist of investment costs for constructing new storage facilities and storage carrying costs. Carrying costs include depreciation on facilities, maintenance, administration, loan amortization, foregone interest on capital tied up in stored grain, loading and unloading costs of rotating stocks through storage, and the cost of grain deterioration and loss.

Government has heavily subsidized private grain storage in the past. Much of the existing storage capacity was originally built under government subsidies. Commodity loan programs, when operative, subsidize a substantial part of the cost of foregone interest on capital tied up in stored grain.² Farmers are frequently induced by income tax considerations to hold additional grain stocks, because storage can postpone realized income to another tax year, which may be beneficial in years when anticipated income is expected to fall. These and other storage and carrying costs could be further subsidized to increase private stocks above the levels that would otherwise be held.³

"TIGHT" VERSUS "LOOSE" AGREEMENT

The "tightness" of an international stockpiling agreement has several aspects, including the number of countries participating, the stockpiling obligations of each

¹ Ronald I. McKinnon, "Future Markets, Buffer Stocks and Income Stability for Primary Producers," pp. 855-860; and Hendrik Houthakker, *Economic Policies for the Farm Sector*, pp. 51-60.

² The CCC's offer to purchase grain from farmers at the loan rate amounts to giving farmers a "put option" to sell grain at that price.

³ Traders, millers, exporters, and other private stockholders could be obliged on a compulsory basis to hold a specified additional stock amount or proportion of their turnover to meet national stock objectives. The Swiss have such a compulsory system, designed to maintain reserves for national defense purposes. See Oberhänsli, "Some Aspects of Stock Holding." The Japanese are considering the use of such a system, as mentioned on p. 54.

country (required domestic stock levels, stock purchase and release prices), and other conditions, such as sanctions against signatories who abrogate the agreement, mechanisms for excluding nonsignatories from stockpiling benefits in times of shortage, and shared responsibility for emergency food relief to needy LDCs. The "loosest" agreement would allow each country to determine freely its own stock policy according to its own benefits from such stocks and its ability to bear the costs of storage, whereas the tightest agreement would leave individual countries almost no direct control over stock policy.

Choosing between a tight or a loose agreement involves consideration of many objectives. For the United States, these include maintaining the autonomy of U.S. domestic agricultural policy, shifting to other countries a part of the U.S. burden of food aid for developing countries, and obtaining trade and other concessions from foreign countries, especially the EC and the Soviet Union.

United States food aid before 1972 was provided mostly from surplus grain stocks accumulated as a by-product of domestic agricultural policy. A "tight" international agreement may be able to delegate responsibility for grain stocks and food aid among all signatory countries, some of which would otherwise avoid what from a U.S. perspective appears to be their full share of food aid responsibility. An international stockpiling agreement could in effect arrange multilateral food aid, in addition to whatever price stabilization it produced. Historically, governments have preferred bilateral aid, because aid transfers furthered the donor country's political and economic self-interests in addition to its humanitarian objectives. *If an international agreement on grain stockpiling is favored primarily for its contribution to world food aid, the alternative modes of food aid and income transfer more generally should be considered.* Analytically, a less expensive means of transferring a given amount of increased wealth to LDCs would be to donate the program funds directly to the countries deserving assistance and allow them to purchase food or whatever they desired more.

A tight stockpiling agreement may be able to bring about international diplomatic objectives of the United States vis-à-vis the EC and the Soviet Union. But the likelihood of achieving these objectives would depend on the particular benefits such an agreement offered to the EC and the Soviet Union and the particular concessions sought by the United States in return. *If the provisions of the agreement are unacceptable to the EC and the Soviet Union, the tightness of the proposed agreement would be irrelevant.*

An international agreement on grain stockpiling that stipulated stock purchase and release prices applicable in all signatory countries would involve synchronizing the price supports in each country. It would probably be difficult to achieve such synchronization, because countries differ in the level of support they provide to domestic agriculture. For example, the 1968 statistics shown in Table 11 illustrate the large diversity in producer prices for wheat. The table shows that the importing countries (EC, USSR, Japan) have had more ambitious wheat price support programs than the exporting countries (United States, Canada, Argentina). Although each country may welcome and advocate an international agreement that implements its own domestic price objectives, international synchronization of price objectives through a grains agreement would require signatory countries to sacrifice autonomy over their own domestic agricultural policy. Consequently, in a tight agreement, it would probably be advisable to stipulate target stock levels rather than purchase and release prices.

Table 11

Producer Prices for Wheat, 1968
(In U.S. \$ per metric ton)

Price	Country
\$40 or less	Argentina
\$40 to \$60	Canada
\$60 to \$80	Denmark, UK, USA
\$80 to \$100	Ireland, Greece, Sweden, Austria, Spain, Turkey, France, Netherlands
\$100 to \$120	Italy, Portugal, USSR
Over \$140	Finland, Japan, Norway, Switzerland

SOURCE: Johnson, *World Agriculture in Disarray*, Table 3.6, p. 56.

VII. SUMMARY AND CONCLUSION

Because of the randomness of nature, annual world grain production is variable and uncertain. Taking the agricultural policies of foreign countries as given, the uncertainty in U.S. grain markets can be characterized by given degrees of variability in the schedules of domestic supply, domestic demand, and export demand. Storage mollifies the effects of supply and demand fluctuations. It serves the useful function of reallocating grain from years of relative abundance and low prices to years of relative scarcity and high prices. It is also beneficial to both producers and consumers because it transforms grain valued at a low price in a period of relative abundance into grain valued at a high price in a period of relative scarcity. The essential economic contribution of grain storage is the stabilization of grain prices. This contribution can be measured by the reduction in the variance of grain price fluctuations. Price stability provides supply "security" to grain importers in the sense that price stability reduces the risk of high grain prices squeezing poor consumers out of the market or driving exporting countries to impose export controls. Assuming that private storage markets are competitive, private storers can be expected to produce the socially desirable levels of grain storage and price stability as protection for grain consumers and producers. The limited evidence that is available suggests that the private U.S. grain storage market is highly competitive. Private storage eliminates some price fluctuations, but some remain. Although more stability of grain prices would be beneficial, because price stability is an economic good, the benefits of additional storage accruing directly to grain consumers and producers would be outweighed by the increased costs of storage.

However, the private storage market neglects nonmarket factors associated with international diplomatic and domestic political objectives, including the provision of food aid. Increased U.S. grain stockpiling may foster U.S. diplomatic and trade objectives in the EC, the LDCs, the Soviet Union, Japan and elsewhere. U.S. Government intervention in private storage markets is seen as justified to the extent that these factors are neglected by the private market. Also, increased stockpiling and price stability may reduce costly domestic functions among grain producers, consumers, and government. While government intervention in private storage markets may seek to account for these nonmarket factors, it is considered to be justified only if it achieves the objectives less expensively than alternative measures and if attaining the objectives is worth the cost. However, government intervention to increase for its own sake the protection of grain consumers and producers from price fluctuations, to combat inflation, or to account for any differential between private and socially desirable discount rates is considered unjustified.

We have tried to focus the discussion of increased U.S. grain stockpiling on several parameters that appear to be essential in ultimate policy decisions and that can be subjected to economic analysis. First, an estimate of the resource cost of obtaining additional price stability can be useful in determining the amount of increased stockpiling desirable for attaining nonmarket objectives.

Existing studies do not focus on this parameter; rather they examine the desirable size of stock, approaching the subject in two ways. One approach mechanically calculates the probability that stockpiles of a given size will be able to offset shortfall

deviations in production. This approach has also been used to calculate stock levels that would result from government-owned stock programs with alternative stock accumulation and release prices. This approach does not provide meaningful information for policymaking because it neglects the presence of private sector storage and so far has not been directed at investigating the resource cost of additional stability. The second approach weighs the consumer and producer benefits and costs from stockpiling. The results from such models do not provide estimates of the desirable government stock because the models essentially model what stock level the private sector can be expected to hold. The forthcoming Rand paper by Keeler summarized in this report modifies this second approach in order to examine the simulated storage behavior of private storers operating under alternative government storage subsidies.

Keeler's simplified and preliminary model, based on projected 1979 U.S. wheat markets, suggests that private storers can be expected to allow wheat prices to fluctuate with a long-run standard deviation of \$.72 per bushel around an assumed mean price of \$2.50 per bushel. Government could expect to reduce this standard deviation by 15 percent to \$.61 per bushel with a \$.15 subsidy per bushel on carryover stocks at an expected cost of \$34 million per year. Or government could expect to reduce the standard deviation by 39 percent to \$.44 per bushel with a \$.30 per bushel subsidy on carryover stocks at an expected cost of \$120 million per year. These subsidy levels are only illustrative. Keeler's work should be refined and extended in future research.

The second key parameter is the rate at which government-owned grain stocks would substitute for (and replace) privately owned stocks. This rate would depend on whether or not government stockholding is profitable in the long run. No previous studies examine this tradeoff, and we offer no estimates. Only since 1972 have U.S. Government stocks been low enough to give private storage the responsibility for holding grain stocks to arbitrage between periods of low and high prices, and a few more years may be required before the private market adjusts to this new responsibility.

However, the substitution of government for private stocks can be avoided by subsidizing the private sector to hold increased stocks rather than by accumulating a government-owned stockpile. The alternative ways in which private storers may be subsidized, and the costs and benefits of each, should be explored in future research. Keeler's simulations examine what is probably not the most effective type of storage subsidy for stabilizing grain prices.

The distribution by which various grain consuming and producing countries and sectors share the benefits from the increased price stabilization (disregarding the conclusion that these benefits in the aggregate are expected to be less than the storage costs) may influence how the costs of an internationally coordinated grain stockpiling system should be shared and how various domestic U.S. interests are likely to react to U.S. grain stockpiling. This distribution is the third parameter that, from our perspective, appears essential to policy decisions.

Although no previous analyses have examined precisely this distribution, economists have demonstrated, for a general case in which markets are competitive, that the net aggregate benefit accruing to consumers and producers from reduced price variance in a particular market is proportional to the reduction in price variance and the sum of the "price responsiveness" (inverse slope) of the demand and supply

schedules. Thus, markets in which the supply and demand schedules are relatively flat benefit most from stabilization of grain prices. Also, the share of the benefits going to each supply or demand sector will be greater the more that price fluctuations arise out of supply or demand uncertainty in that sector and the flatter is that sector's supply or demand schedule. Thus, most benefits are likely to accrue to foreign consumers, less to U.S. producers, and least to U.S. consumers. This result assumes that most of the market uncertainty arises in the U.S. export demand schedule, with some arising in a U.S. supply schedule that is not perfectly inelastic. The benefits are likely to be greater, per unit of price variance reduced, for feed grains than for food grains, because feed grain demand and supply are thought to be relatively price-responsive.

This analysis assumes that average grain prices are neither raised nor lowered by the imposition of the storage and price stabilization program.

Depending on the particular storage program, price stabilization may entail an increase or decrease in the average or expected level of grain prices. We examine one price stabilization program that is hypothesized to involve a once-for-all decrease in the expected level of grain prices, and another program associated with a short run increase in the average price of grain. The change in the expected price level may have welfare effects that are stronger than those associated with price stabilization, per se.

Elsewhere in the report, we provide a background discussion of the forces contributing to the post-1972 rise in world grain prices. The evidence suggests that the price increase is largely explained by factors unrelated to the depletion of U.S. grain stocks over the period. The adjustment of world grain markets to aberrations in world grain supply and demand between 1972/73 and 1974/75 was concentrated in the United States and a few other grain exporting countries by trade barriers which insulated grain prices in large parts of the world from the events in world grain markets.

We comment on factors related to the usefulness of U.S. grain stocks for obtaining the U.S. Government's international objectives. We question the value of stockpiling for attaining such objectives because many of the agricultural trade concessions that the United States seeks in return for increased U.S. grain stocks would require foreign countries to give up protection of their domestic farm policies, which history indicates they will be reluctant to do. Also, if the United States fails to increase its stocks, most foreign countries can increase their own stocks instead, or continue their current agricultural policies that insulate their home markets from price instability in world markets.

We comment on the effects on various domestic groups of increased U.S. grain stockpiling. These groups cannot all be satisfied simultaneously because their goals conflict.

We suggest that grain stock and food aid policies should be formulated independently. If possible, food aid demand should be formulated and announced before food aid demands arise, so as to assist the private market in storing additional grain in anticipation of government food aid shipments during poor harvest years. The administrators of the food aid budget may find it desirable to hedge their food aid requirements by stockpiling or by operating in the grain futures market.

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