Increasing World Grain Market Fluctuations: Implications for U.S. Agriculture

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Abstract

Domestic and foreign import and export policies which restrict trade, along with increasing variability in exchange rates, are causing increased fluctuations in U.S. grain exports and are making U.S. farmers increasingly uncertain about the prices they can expect and about what they should produce. Farmer uncertainty reduces production, raises prices for consumers, and may accelerate structural changes in the farm sector. These problems may worsen over the next 20 years if other countries further insulate their domestic markets from variations in the world market. As export markets grow in coming decades, U.S. grain policies can be tailored to mitigate such impacts; but the alternatives may also involve undesirable side effects.

Keywords: market fluctuations, price variability, grain export variability, uncertainty, risk aversion, structure and organization, policy.

Preface

This study is part of a world food study undertaken by USDA's Economic Research Service. Concerns addressed by the overall study include future trends in U.S. agricultural exports, prospects for increases in domestic productivity, and resulting implications for the U.S. soil and water resource base and capacity to produce. This study reviews the sources and amounts of instability in U.S. agricultural markets, estimates the impacts of this instability on the farm sector, and discusses the resulting policy issues.
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Summary

Fluctuations in the price for U.S. grains create uncertainty for U.S. farmers. Uncertainty affects price expectations and may influence planting and marketing decisions. While price movements are necessary to provide signals to producers to guide their allocations of resources, excessive price variability can also lead producers to reduce production in an attempt to gain protection from risk. Alternatively, producers may choose to maintain given levels of production but only at higher prices to cover the risk premium that they perceive.

Exports have become a major source of demand for U.S. crops. This expanded demand has brought with it many benefits. However, the larger export market has also increased price uncertainty. The effect of this uncertainty has been especially pronounced for U.S. farmers. Many countries have sheltered their producers or consumers, or both, from the variability of world markets by exporting or importing grains with little regard for world prices. In contrast, U.S. export markets have been kept open to world trade influences, absorbing much of the variation that occurs through domestic production controls and stockholding.

With complete stability of prices, perfect foresight by producers would be assured. In the fifties, something approaching that situation occurred in the United States with high support prices setting market prices which changed relatively little from year to year. In these conditions, producers were able to plan with considerable certainty, and U.S. production increased about as much as the programs allowed. But resources were being misallocated to meet a demand created mostly by the programs and economic efficiency did not result.

Price variability increased with the programs of recent years, but much of the risk was shifted to the public through disaster programs, target prices and deficiency payments, and other devices. Overproduction, which is inconsistent with economic efficiency, resulted in some regions.

Price uncertainty can lead to a loss in economic efficiency, but this must be weighed against the costs and benefits of expanded U.S. grain trade and improved balance of payments.

In this report, the implications of increased price variability are analyzed, particularly as such variability might arise through world market forces. Also examined are the pro's and con's of policy alternatives for dealing with this source of uncertainty in an agriculture with a goal of expanding export markets.

Results suggest that if variability in export demand from one year to another were to double from the level of the seventies, production of major U.S. crops could drop by 2 to 5 percent; or to elicit the same production, prices would have to average 2 to 8 percent higher. Export variability could, in turn, affect the structure of the farm sector by accelerating trends of farm consolidation, diversification, vertical integration, more complex forms of farm business organization (like corporations), part-time farming, and forward contracting.

If production is reduced and prices subsequently rise in response to increased price variability, a loss in economic efficiency would occur. This would lead to increased prices at all levels, reduced aggregate demand and consumer real income, and possibly less incentive for farmers to adopt soil conservation practices. The extent of the efficiency loss would depend upon farmers' response to risk—that is, their willingness to bear periodic downturns in prices. Given the available evidence on farmers' risk preferences, the net efficiency loss might be relatively small. It would nevertheless represent a reduction in economic welfare for those involved in and served by the U.S. food system.

The public interest in this issue focuses on how to achieve the benefits of increased exports while minimizing the loss in economic efficiency as U.S. farmers face greater price uncertainty. It also involves the consideration of what, if any, policy actions might be taken to moderate price uncertainty. These alternative policy responses have other costs and benefits that must be considered, too. Public intervention has been used in the past to support prices received by farmers. Of the general types of public programs that have been used, the more important tend to be price supports for U.S. grain crops, production controls, and grain stockholding. Important in the future will be the likelihood and magnitude of price uncertainty, particularly as generated in the export market, and the public's assessment of the tradeoffs inherent in policies for dealing with it.

Four general strategies for the United States are analyzed in this report (see table). Some groups would gain and others would lose depending upon the strategy chosen. The increased price variability associated with low price supports (and with high price supports and low stockholdings) would increase risks to producers and create other social costs. But
tradeoffs go well beyond the issues associated with producer risk and farm structure. As summarized in the table below, consumer prices, taxpayer costs, and foreign exchange earnings are also at stake.

High price supports can minimize price variability, but Government stocks would be large, costs high, and producers may be reluctant to accept the strict production controls required to control stock levels. The main beneficiaries of high price supports would be current landowners, who would receive higher rents as program benefits became capitalized into land values, and other exporting countries, who would increase their export share.

With low price supports, price variability could still be substantial, leading to a persistent reduction in agricultural production. Public programs to supplement grain stocks could mitigate some of this variability. Low price supports would cut Government costs and allow U.S. farmers to expand their grain exports, and would benefit producers, input suppliers, grain marketing firms, U.S. consumers, taxpayers, grain-importing countries, and, in the long run, U.S. farmers.

### Impact of U.S. grain policy alternatives

<table>
<thead>
<tr>
<th>Item</th>
<th>High price supports</th>
<th>Low price supports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High stocks</td>
<td>Low stocks</td>
</tr>
<tr>
<td>Average grain price level</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Expected price variability</td>
<td>low</td>
<td>relatively high</td>
</tr>
<tr>
<td>(U.S. and world prices)</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Volume of grain production</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Volume of grain in storage</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>U.S. grain export volume</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Government program costs</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>
INCREASING WORLD GRAIN MARKET FLUCTUATIONS

IMPLICATIONS FOR U.S. AGRICULTURE

Thomas A. Miller, Jerry A. Sharples, Robert M. House, and Charles V. Moore

Introduction

Foreign markets will continue to be vital to U.S. farmers. However, the world food balance is expected to oscillate between years of excess production and very tight supplies, causing variability in world grain prices. Some analysts have argued that foreign market prices could become even more variable with the United States continuing to be the major adjustor of production in world grain markets. Domestic policies of major grain exporting and importing countries, who insulate their prices from world markets, could lead to further destabilization of world prices.

Since 30-40 percent of U.S. harvested acreage is for export, changes in export demand are transmitted directly to domestic grain prices, which signal producers how to allocate resources in response to changing market conditions. Extreme market fluctuations, with associated price uncertainty, have undesirable impacts on producers, U.S. agriculture in general, and the entire U.S. economy. Increasing world grain market fluctuations reduce production and lead to speculative investment and concentration in the U.S. farm sector.

With complete stability of prices, perfect foresight by producers would be assured. In the fifties, something approaching that situation occurred in the United States with high support prices setting market prices which changed relatively little from year to year. In these conditions, producers were able to plan with considerable certainty, and U.S. production increased about as much as the programs allowed. But resources were being misallocated to meet a demand created mostly by the program and economic efficiency did not result.

Price variability increased with the programs of recent years, but much of the risk was shifted to the public through disaster programs, target prices and deficiency payments, and other devices. Overproduction, which is inconsistent with economic efficiency, resulted in some regions.

Price uncertainty can lead to a loss in economic efficiency, but this must be weighed against the costs and benefits of expanded U.S. grain trade and improved balance of payments.

This report assesses the implications of increased world grain market fluctuations on U.S. agriculture. Specific objectives were:

- To identify the major sources of variability facing U.S. agriculture and to assess potential increases in variability.
- To appraise the impact of increasing price uncertainty on farm production efficiency and aggregate supply response.
- To identify the impact of increasing variability and uncertainty on investment, financial structure, and organization of the farm sector.
- To identify the implications of price variability in the world market for U.S. grain policy.

Sources of Variability in U.S. Farm Markets

The economic environment surrounding U.S. agriculture became much more variable in the seventies than at any time following World War II. This variability will
Increasing World Grain Market Fluctuations

probably continue. All aspects of agriculture are variable. Yields vary according to weather and natural conditions, markets vary, financial and economic conditions vary, input and product prices vary. All of these lead to variability in farm income, which fluctuated during the seventies in sharp contrast with relatively stable farm income in the fifties and sixties (fig. 1). For over 20 years, net farm income hovered in the $12-$15 billion range, then in the seventies ranged from $15 billion to nearly $35 billion. Tweeden found the relative variation in real net farm income, measured by the coefficient of variation, increased from 6.9 percent during the sixties to 29.1 percent for 1970-75 and 22 percent for 1976-81 (71).^1

Fluctuations in world markets are transmitted to the U.S. agricultural sector through the prices that farmers receive, particularly for grain products. Table 1 shows that the variation in prices received, cash receipts, and personal income of the farm population have all increased in recent years.2

The net farm income portion (without Government payments) of personal income is the most variable. Income received by farmers from nonfarm sources has increased in recent years, has become a little more stable than farm income, and tends to reduce the variation in the total income of farmers. The growing importance of nonfarm income, with its attendant stabilizing effect, appeared to be slowing the increase in variability of total income by the start of the eighties.

Price variability creates risk and uncertainty for private and public decisionmakers. However, some kinds of variability are more easily dealt with than others.

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For example, yield variability is likely to be constant over time, given the same technology. Thus, while decisionmakers do not know precisely what yield will be

Figure 1

Instability of Net Farm Income Over Three Decades*

<table>
<thead>
<tr>
<th>Year of decade</th>
<th>1950's</th>
<th>1960's</th>
<th>1970's</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-59</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>1960-69</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>1970-79</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

*After inventory adjustment.
Source: (76).

---

Table 1—Variation in U.S. farm income and product prices, selected periods, 1955-78

<table>
<thead>
<tr>
<th>Item</th>
<th>Coefficient of variation^1</th>
<th>1955-63</th>
<th>1964-71</th>
<th>1972-81</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index of prices received:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All products</td>
<td>2.6</td>
<td>5.9</td>
<td>19.4</td>
<td></td>
</tr>
<tr>
<td>Crops</td>
<td>2.9</td>
<td>3.8</td>
<td>19.4</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td>5.5</td>
<td>11.3</td>
<td>21.4</td>
<td></td>
</tr>
<tr>
<td>Cash receipts:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crops</td>
<td>10.4</td>
<td>9.1</td>
<td>27.9</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td>8.3</td>
<td>14.6</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>Personal income received by the farm population:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm income less Government payments</td>
<td>9.4</td>
<td>18.6</td>
<td>23.4</td>
<td></td>
</tr>
<tr>
<td>Farm income</td>
<td>6.3</td>
<td>14.1</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>Nonfarm income</td>
<td>12.5</td>
<td>16.0</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>From all sources</td>
<td>5.5</td>
<td>12.1</td>
<td>15.0</td>
<td></td>
</tr>
</tbody>
</table>

^1The coefficient of variation is the standard deviation of the data series divided by the mean. It is expressed here as a percent.
Sources: (75, 76).
attained, it is possible to assign statistical confidence intervals to prospective yield levels and make decisions accordingly. On the other hand, the variation arising from Government policies of importing and exporting countries may change as the policies change, and there is no way to foresee such events. Since Government actions are an increasingly important source of price variability in world markets, we are concerned with a type of variability that is difficult to forecast or measure statistically. The term “uncertainty” is sometimes used to describe such a phenomenon, as opposed to the measurable risk of yield variation (26, ch. 15).

**Historical Price Variability**

A look at prices received by U.S. farmers for wheat and corn during this century reveals how price variation has changed over time and also illustrates differences between absolute and relative price variation (table 2). Absolute variation can be measured by the standard deviation of the price series. The standard deviation of wheat prices ranged from 14-91 cents while the standard deviation of corn prices ranged from 13-56 cents. Between 1971 and 1982, the standard deviation for both wheat and corn prices reached all-time highs.

The large amount of absolute variation from 1971-82 is partially related to the higher average level of prices. The coefficient of variation, which measures price variation relative to the average level of prices, shows a different pattern. Although prices in the seventies were more variable than those in the fifties and sixties, they were far less variable than in 1915-50.

Both measures of price variability suggest that prices received for grain by U.S. farmers were comparatively stable during 1950-71. Price changes during this time (reductions in 1958, 1963, and 1964 and an increase in 1962) were due to adjustments in domestic support prices under commodity programs that maintained U.S. prices above world levels. Wheat prices did increase in 1966 and 1967 in response to perceived scarcity in the world market. Massive Government intervention throughout this 22-year period stabilized farm incomes and farm prices above world levels and above prices that would have existed in the absence of such programs.

Massive stocks were accumulated under these programs, reaching 1.4 billion bushels of wheat and 2 billion bushels of corn in 1960. These stocks insulated U.S. prices from world markets from 1950-71. Grain exports during this period were viewed as a disposal of surplus stocks and were generally under P.L. 480 (concessional exports) when domestic prices were supported above world market levels. Export markets were generally relatively stable and not large enough to bring domestic prices above the price support levels set by commodity programs.

Changes in domestic yields and acreages were likewise insulated from the market by price support policies during this period. Little relationship is shown between production variation and domestic prices, even during the late sixties when markets operated more freely and stocks were at lower levels.3

The relative stability of grain prices during 1950-71 contrasts sharply with the situation after 1972. By the early seventies, growth in export markets had brought the demand for U.S. agricultural products more in line with capacity. At the same time, large inventories of

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**Table 2—Variability of wheat and corn prices, 1900-82**

<table>
<thead>
<tr>
<th>Period</th>
<th>Wheat</th>
<th></th>
<th>Wheat</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average price</td>
<td>Standard deviation</td>
<td>Coefficient of variation</td>
<td>Average price</td>
</tr>
<tr>
<td>1900-15</td>
<td>0.82</td>
<td>0.14</td>
<td>17</td>
<td>0.54</td>
</tr>
<tr>
<td>1915-38</td>
<td>1.12</td>
<td>.49</td>
<td>44</td>
<td>.80</td>
</tr>
<tr>
<td>1938-50</td>
<td>1.41</td>
<td>.55</td>
<td>41</td>
<td>1.12</td>
</tr>
<tr>
<td>1950-71</td>
<td>1.73</td>
<td>.31</td>
<td>18</td>
<td>1.23</td>
</tr>
<tr>
<td>1971-82</td>
<td>3.13</td>
<td>.91</td>
<td>29</td>
<td>2.30</td>
</tr>
</tbody>
</table>

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3As pointed out by Tweeten (72, p. 208) there was a considerable amount of domestic production variation during the period. However, production variation did not cause price variation, because of Government price support programs.
Increasing World Grain Market Fluctuations

grain had diminished. Thus basic conditions were established by the early seventies to greatly increase the variability of farm prices.

World grain production fell by about 3 percent in 1972, partly because of adverse weather in some parts of the world, including the Soviet Union, and partly because of continued production controls in the United States. In a major policy shift, the Soviet Union then entered the world market in mid-1972 to purchase 23 million metric tons of grain, about 60 percent of it from the United States. Yearend world grain stocks fell to 12 percent of annual use in 1972, compared with 20 percent in the early sixties. While conditions stabilized to some extent in 1973, a 1974 drought reduced U.S. corn production and contributed to another 4-percent decline in world grain production.

Price shocks were extreme; grain and soybean prices reached record levels. These high prices benefited crop producers but were a factor causing livestock producers to face one of the most unprofitable periods in history. Sharply rising food prices precipitated export embargos that strained longstanding trade relationships. The upswing of crop prices from 1972 to 1974 encouraged many farmers to make large capital investments to expand their production with the expectation of permanently higher prices and income. But prices dropped in 1976 and 1977 as production improved and stocks increased, and even though incomes rose in 1979 and 1978, they fell 30 percent in 1980 as inflation-induced increases in expenses cut into gross incomes. Increased production and slackening export demands further cut farm prices and incomes in 1981 and 1982, greatly increasing wheat and corn stocks at the same time.

Figure 1 shows how these events affected net farm income in the United States. The most important feature is the stability during the fifties and sixties, in contrast with what happened in the seventies. While the variation of the seventies may not be high by comparison with what existed prior to World War II, it is certainly high when compared with the 1950-71 period, when many current farm operators and owners started business. It is small consolation to these farmers that prices were even more variable earlier; they are concerned with adjusting operations to cope with the latest increases in price variability and uncertainty.

Sources of Variability in the Seventies

Natural factors, international monetary conditions and exchange rates, trade policy, and the absence of adequate buffer stocks appear to be responsible for the rapid upswing in prices in 1972-74 and the fluctuations in world grain markets since.

Natural Factors. Variation in crop yields caused by weather, disease, and other natural hazards was amplified by production's having expanded onto semiarid lands in the seventies, as happened with India's agriculture (25). Improved seed and fertilizer-based technologies also contributed to increased yield variability, particularly in semiarid regions with limited irrigation (24). Crops grown with the new technologies may be more sensitive to weather and disease, as well as year-to-year changes in input use. Little information is available, however, on the actual extent to which such natural factors lead to increased variation in world markets. Irrigation offsets at least part of this variation.

Expansion of wheat production in the Soviet Union within a narrow latitudinal belt (which makes it particularly vulnerable to droughts) greatly increased production variability. The USSR now is the source of approximately 40 percent of the total annual world variation in wheat production. This fact increases the significance of the Soviet's 1972 decision to make up for such crop failures in the world market. Whether or not variation in world grain production has actually increased, the Soviet policy means that much more production variation is transmitted to world markets than was the case before 1972 (54).

U.S. yield variation due to droughts and crop disease, while small in comparison with that of the rest of the world, cannot be overlooked as a contributing factor. U.S. average yields of corn dropped by almost 20 percent between 1979 and 1980, a year in which U.S. corn prices increased by 59 cents per bushel (23 percent). Expanded acreages of wheat and corn may be increasing yield variability even in the United States. The U.S. corn leaf blight problem in 1970, fostered by a narrowing of the genetic base of seed corn, may also represent an increased vulnerability of U.S. crops to natural hazards. Crop breeders, however, are quick to point out that seed lines have been diversified since that time, eliminating much of this hazard.

International Monetary Conditions. Grain price variability may also result from changes in international demand for grain induced by changing world economic conditions, shifts in international currency exchange rates, or changing conditions in international financial markets (61). Since international exchange rates were inflexible until 1972, international monetary conditions were not a significant source of variability for U.S. markets during the fifties and sixties. But with the
devaluation of the dollar in 1972 and the adoption of floating exchange rates by the world monetary system, U.S. farmers found themselves exposed not only to changes in world crop production and trade policies, but also to variations in the strength of the dollar compared with currencies in major grain-importing countries.

The initial devaluation of the dollar in 1972 and 1973 caused lower grain prices in countries buying U.S. grain products. Wheat exchange rates—the value of the dollar compared with currencies of countries buying U.S. wheat—declined by 7 percent in 1973, and corn exchange rates by 17 percent. These declines in the dollar's value made U.S. farm exports better buys in many parts of the world and contributed to increased exports during 1972-74.

Since then, the dollar has strengthened, particularly against currencies of the less developed countries that are the major importers of U.S. wheat. At the start of 1983, the wheat exchange rate had increased by 523 percent and the corn exchange rate by 120 percent compared with 1971 (68). This strengthening of the dollar against the currencies of countries who are major U.S. wheat customers, together with slackening demand due to their sluggish domestic economies, was primarily responsible for the reduction in wheat exports and decline in wheat prices in the United States in 1981 and 1982 (42). These data reinforce the contention that unstable monetary conditions are now an important contributor to U.S. grain market instability.

Other analysts have recently highlighted the significance of the appreciation of the U.S. dollar for export prices, exports, and surplus grain stocks (17, 41, 43, 62, 69, 77). They support the general conclusion that macroeconomic developments and changes in the exchange rates have a great influence upon the farm sector and that increasing monetary instability made world commodity markets more unstable in the seventies. The adjustment of the economy in response to changes in fiscal and monetary policy greatly affects U.S. agriculture. Such monetary factors have clearly been a source of increased cyclical (beyond 1 or 2 years) variation in U.S. grain markets since 1972.

**Trade Policy.** Trade policies of both exporting and importing nations played a major role in the rapid upswing in prices during 1972-74 and the fluctuations in world grain markets since (8, 16, 33). First, the principal exporting countries reduced their stocks in the early seventies, through production controls in the United States and stock disposal in Canada. Second, the Soviet Union entered the world market as a significant importer of wheat in response to a poor domestic harvest. The Soviet Union previously had adjusted domestic consumption in response to crop failures rather than entering world markets to make up deficits. This change in policy also put substantial pressure on available grain stocks. Finally, both exporting and importing nations, seeking to limit the impact of rising international market prices upon domestic market prices, contributed to a further rise in world grain prices. U.S. grain embargoes were a part of this process.

Protective policies aggravate price variability as illustrated by the following hypothetical example (30). Assume that the world has a 4-percent grain shortfall and the price elasticity of demand for grain for the world is -0.1. If all countries proportionally shared this shortfall, all would reduce consumption by 4 percent and the world price would increase by 40 percent. This result represents a completely free trade situation. Alternatively, if half of the world decides not to reduce consumption, but to maintain it at previous levels by increasing imports, then the 4-percent world shortfall requires the remaining nations to restrict consumption by 8 percent, and world price will increase by 80 percent. In this way, policies that insulate individual countries from world supply and demand adjustments increase the variability and burden of adjustment on the remaining countries.

The Soviet Union, Europe, and China—all grain-deficit countries—consumed half of the world’s grain in recent years. These countries greatly increased their world grain trade in the seventies, while strongly adhering to policies that protected internal consumption and price levels. The policy changes in these countries in the late sixties and early seventies—basically stabilizing domestic markets at the expense of the world market—ushered in the new era of world market variability.

Other analysts have clearly demonstrated the relationship between insular policies and world market variability (6, 20, 48, 64). Restrictive trade policies of both exporting and importing countries—undertaken to insure stable domestic supplies and prices—in effect transfer the variability within such countries to the rest of the world.

Blandford’s conclusion is typical:

...The largest potential absolute transmission of domestic variability is attributable to the Soviet

---

*The practice of exporting countries' subsidizing sales after bumper crops in the early eighties provides another realistic example.*
Increasing World Grain Market Fluctuations

Union, an effect which is further accentuated by evidence of actively destabilizing response to world price fluctuations. Given the events which followed the large USSR purchases in 1972-1973 and the eagerness with which grain exporters have since sought to sign bilateral supply/purchase agreements with the Soviet Union, this is perhaps not surprising. It is interesting that the EEC is ranked second for both wheat and coarse grains. The results indicate the EEC may potentially transmit a larger proportion of its grain market variability to world markets than the USSR. The effect is particularly marked in the case of coarse grains (6).

Australia and Argentina are important potential transmitters of domestic variability to the world market. Only the United States, through its trade and stockholding policies, helps to stabilize the wheat and coarse grain markets (8).

Trade policies of both exporting and importing countries to insulate and stabilize internal prices were a major factor increasing world grain market fluctuations in the seventies. Increased reliance on such trade policies by other countries has been the primary source of greatly increased variability in U.S. grain export markets.

Buffer Stocks. The experience of the seventies suggests that the lack of world and U.S. grain stocks magnified market variability in the early seventies and that variability in the 1979-82 period would have been much greater had it not been for the stocks in the U.S. farmer-owned reserve (FOR) program. During the fifties and sixties, international grain prices were quite stable and there was no shortage of supply, primarily due to the huge stocks accumulated as a byproduct of domestic price support policies in Canada and the United States. While large quantities were consigned to storage in the fifties, these stocks had been worked down to what appeared to be more realistic levels by 1971. The drop in world grain production in 1972 reduced the world stocks of all grains to 11.8 percent of annual consumption—down drastically from the 15- to 20-percent range of the previous decade (21). Domestic U.S. grain stocks fell from 74 million metric tons in 1971-72 to 28 million metric tons in 1974-75. These lower stock levels substantially increased the impact of world crop production variability on domestic U.S. prices, touching off a new era of world market variability (6, p. 116).

Of the major grain-exporting countries, only the United States and Canada managed grain stocks in a way to reduce world price variability (80). Grain stocks of all other exporters respond more to domestic production and policy considerations than to world market conditions. Australia, Argentina, and France keep small grain reserves but absorb very few year-to-year fluctuations in production. Instead they transmit fluctuations directly to the world market via exports of excess supplies, regardless of world price levels. Importing countries are generally motivated by the need to stabilize domestic prices and supplies rather than the need to maintain stable international prices. No importing countries hold significant buffer stocks.

In the last few years, the United States has held about a third of the world’s wheat stocks and about half of the world’s coarse grain stocks. But when one distinguishes between working stocks (pipeline stocks) and buffer stocks (stocks managed in a way to reduce price instability) the U.S. role is even greater. Grain stocks held by the rest of the world appear to be working stocks; the world’s buffer stocks appear to be held almost entirely in the United States (46). The rest of the world depends on continued U.S. farmer stockholding as the main stabilizing force in the world market. Farmer-held U.S. buffer stocks were the primary factor reducing world market variability in the late seventies and continue to shoulder nearly all the burden of maintaining buffer stocks to mitigate increasing world market variability. However, U.S. stockholding is often insufficient to bring a significant degree of stability to world markets, and U.S. farmers are increasingly faced with boom and bust conditions. Even a superficial look at the 11 years following 1972 makes this point clear.

Prospects for Variability in World Grain Markets

The abrupt increase in U.S. price variability in the seventies was primarily caused by increasing fluctuations in export demands, which were responsible for 96 percent of the variation in U.S. grain demand during 1976-81 (71). Inasmuch as a good portion of the variability in world grain markets stems from policies of various grain exporting and importing countries, changes in the amount of variability depend on changes in these policies, actions that are nearly impossible to forecast. Thus a key determinant of the amount of future world market variability is always unknown.

Potential for Variability is Increasing. While considerable uncertainty surrounds the issue, a variety of factors could cause world market variability to increase.
further. Most of the potential variability in world market prices derives from the effects of production fluctuation in importing countries. Importer trade restrictions to stabilize internal prices tend to make trade less price elastic. The less that imports (and exports) adjust to changes in world supply and demand conditions, the more volatile are world price changes.

World grain production in the seventies became concentrated in countries with relatively variable yields like Argentina, Australia, and Canada (8). The increased reliance on world supplies from these countries means an increased potential for supply variability. "Furthermore, the growth in the import shares of the developing and centrally planned economies means that potential instability in the world market is increasing, because of the higher production variability and a degree of transmission of this variability to the world market" (65, p. 6). These results suggest that price variability in the world market is increasing, and the likelihood of future large price deviations around trend has risen considerably.

The United States is the only exporter with sufficient storage capacity and a storage program that allows significant export response to short-term price fluctuations. However, stockholding, the basic way of mitigating these potential fluctuations, may also be on the decline in exporting countries (as exemplified by the U.S. Payment In Kind program) and in the developing countries. With less stockholding, the potential for variability in world grain markets will likely increase during the eighties.

Others have also concluded that price variability will likely increase in the eighties (3, 4, 29). Their conclusions generally emphasize that the structure of world grain trade is becoming increasingly dominated by state trading organizations, bilateral agreements, and other trade restrictions that limit supply and demand adjustments. Since an increasing number of domestic markets are insulated from world prices, an increasing adjustment burden will have to be met by the residual world market and the domestic U.S. market (32). While such forecasts may be in error, Bain's conclusion "...that a chronically unstable...situation is more clearly within the feasible set of forecasts than has been the case over most of the last three decades" certainly seems appropriate (3).

Few Prospects for Trade Liberalization. While policies of countries to protect domestic prices contribute to world market variability, market variability also leads to protective policies (6, p. 250). As price variation in the world market increases, developing countries try to insulate their economies from the world market and achieve self-sufficiency. These countries accuse free trade of causing instability, depressing agricultural production, and increasing dependence on risky world market supplies. Thus the tendency, as world market variability increases, is for developing countries to display precautionary purchasing behavior and to use restrictive trade practices to insulate domestic prices and consumption from world markets, further increasing existing market rigidity. "Although all of these measures may have justifiable aims, collectively they seem likely to further accentuate potential price instability in the world wheat market" (10, p. 11). There is little indication that trade policy changes will be made in either importing or exporting countries to lessen world market variability.

Price Variability and the U.S. Response

The U.S. response to fluctuations in world markets has major implications for the agricultural sector at home and abroad. The private grain sector (producers, marketing firms, etc.) without Government assistance is capable of providing some stability to world and domestic grain markets by its own competitive stockholding operations. But substantial price variability could remain with resulting effects upon the structure and performance of the agricultural sector. Government policy could substantially reduce the price variability faced by U.S. agriculture. But Government intervention also tends to lead to large budget outlays and to create other problems. These Government policy tradeoffs are discussed in the last section of this report.

Price variability in U.S. grain export markets works its way through the agricultural sector in many ways. While some changes in prices are necessary to allocate production and to eliminate inefficient producers, too much fluctuation increases the risk and uncertainty faced by producers and reduces economic efficiency and welfare. Excessive price variations reduce production efficiency, increase marketing costs and retail prices, reduce consumer welfare, and reduce the real income levels of consumers. Price variability also affects the scale and structure of agriculture, how farming is financed, who owns the factors of production, and the distribution of returns to factors, and, eventually, the distribution of wealth in agriculture.

A key question then becomes how increased price variability affects the ability of U.S. agriculture to meet growing export needs. "Although the [impact of uncertainty on productivities] has never been measured quantitatively, it is likely that inefficiency growing out of
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economic uncertainty is more important than any other single source of inefficiency" (26, p. 740).

This section appraises the impact of increasing world grain market fluctuations on farm production efficiency and aggregate supply response in the United States. This appraisal is done in the context of increased volatility in world markets over the next 20-30 years. The first issue to be addressed is how increasing price variability shifts the aggregate supply function of U.S. agriculture.

Risk Response in Agriculture

Increased price variability at the farm level results in uncertainty about future prices and increases the risk associated with farm production. The response of farmers to this increased risk is complex. It may involve diversification, flexibility, liquidity, capital rationing, or other adjustments in production, marketing, and investment (72, p. 211). The net extent of these adjustments depends upon how individual farmers avoid or discount risky enterprises, or more technically, their risk premium, risk preference, or risk aversion (2, 34, 53, 83).

Diversification is probably the most common adjustment to price uncertainty. Increasing the number of enterprises on a farm reduces the probability that the farmer will have drastically low net incomes from all enterprises in the same year. Chances are that if the prices of grain products drop because of reduced export demands, livestock prices will drop less or may even rise. Hence a diversified crop-livestock farm has less income variability than a specialized grain farm. On the negative side, diversification generally reduces production and income because it reduces farmers’ ability to specialize in enterprises where management ability or resources are best suited, reduces eligibility for price premiums on large-volume product sales, and may lead to less efficient use of machinery and the physical plant. Thus while diversification may reduce income variability, it may also reduce total production and average income.

Farmers also guard against price uncertainty by maintaining flexible plans. This flexibility allows farmers to adjust to changing price expectations. To maintain flexibility in changing enterprises from year to year, farmers may forego large investments in specialized production facilities, they may rent equipment, land, and buildings, and they may hire custom services rather than make the long-term commitment to own these items. Such flexibility reduces risk but also foregoes the efficiency of specialized facilities and leads to inefficient input mixes and investment decisions.

Another response to uncertainty is to increase the discount rate (or the risk premium component of the discount rate) used in investment decisionmaking (13, 14). That means that farmers refrain from making long-term investments, reduce soil conservation practices, borrow less capital, and maintain excessive liquidity instead of investing money in productive farm enterprises. While each of these responses increases the ability of an individual farmer to withstand year-to-year price variability, they also lead to inefficient allocation of resources, compared with a risk-free environment.

Finally, farmers may attempt to reduce the uncertainty through insurance, off-farm employment, or other techniques (26, 72). These adjustments tend to reduce the production and efficiency of the farm enterprise, or increase the cost of operation.

Risk Premiums and Risk Response. To estimate the impact of increasing grain price variability on U.S. agricultural production response, one must consider the net impact of all these adjustments. The impact is difficult to quantify because the adjustment that is optimal for one farmer may be inappropriate for another. Unique characteristics of the individual farmer and farm, including management abilities and asset and debt structure, attitude to risk taking, and the physical size and characteristics of the farm, affect which adjustments are made and to what degree.

The general concept of a risk premium or discount represents an attempt to quantify the total impact of these adjustments to uncertainty for an individual farmer. The absolute risk premium, measured in dollars, represents the dollar amount by which a producer discounts net returns from a particular risk enterprise or farming activity; and the relative risk premium expresses this discount as a proportion of the expected net income from the activity. For example, a relative risk premium of 0.25 means that the decision-maker discounts net returns from a risky enterprise by 25 percent in making production and resource allocation decisions.

The relative risk premium provides an understandable measure to compare different empirical measurements of producers’ attitudes to risk. Newbery and Stiglitz estimate relative risk premiums of from 10 percent of income to 25 percent of income, showing that high risk can be quite costly to farmers. They conclude, "it is apparent, then, that the welfare losses with which we are
concerned, arising out of the risk facing farmers, are significant, and that policies which change these risks may have significant welfare consequences." (48, p. 110).

Only a few empirical studies have attempted to quantify the impact of increased price uncertainty and risk premiums on supply response. Just investigated the importance of risk on field crop supply response in California (34). He concluded that the increased production that resulted from stabilization of prices through Government programs in the sixties may have been important enough to offset the acreage reduction provisions of these same programs. This result suggests that changes in risk associated with increasing price variation may substantially reduce the aggregate supply function.

In another study, Lin used an econometric model to estimate the effect of changes in the coefficient of variation of price on aggregate production in the Plains (38). His results suggest that a doubling of price variability—for example the coefficient of variation increasing from 10 percent to 20 percent—would reduce production of wheat in the Great Plains by about 3 percent.

Bigman argues that a reduction in risk, when producers are risk averse, "...is likely to lead to a more efficient allocation of resources, a choice of more efficient techniques, and an allocation of more resources for production and hence more output and lower price" (6, p. 57). He concludes that the efficiency gains from price stabilization are more important than the distributional gains, and that the aggregate supply function is very sensitive to changes in the standard deviation of price (6, p. 76). This conclusion, however, may apply more to low-income developing countries than to U.S. farmers.

**Technical Measures of Risk Response.** Analysts have attempted to conceptualize and quantify farmer response to risk in more technical terms. Much of this work focuses on measuring the risk preference or risk aversion of individual decisionmakers. Some readers may want to skip this section and go directly to the estimates of aggregate impact of increasing price variability. The technical work is reviewed here as a necessary foundation to the results that follow.

Young provides a recent survey of attempts to measure farmer risk preferences (83). Reviewing 11 empirical studies, he found that risk-averse farmers generally out-number risk-neutral and risk-prefering farmers. These studies also support the widely accepted hypothesis that risk aversion decreases with respect to wealth. However, risk preferences were elicited from relatively few agricultural producers, and the samples were not clearly representative, making generalizations of empirical evidence to general populations tenuous.

Young's review describes numerous empirical methods and different coefficients that attempt to quantify producer risk response. Definitions of a few risk measurement concepts are useful. The absolute risk aversion coefficient is an abstract concept describing the curvature of producer utility functions (53). The size of this coefficient depends on the units in which income is measured (48, p. 72). Thus the income level must be specified to give meaning to the value of this coefficient. King and Oamek surveyed Great Plains wheat producers for absolute risk aversion coefficients and found values from 0.00001 to 0.00004 for net income levels in the $10,000 to $40,000 range (35). They termed coefficients of 0.00001 as representing slightly risk-averse decisionmakers and coefficients of 0.00004 as representing decisionmakers who were quite risk averse.

The relative risk aversion coefficient is defined as the absolute risk aversion coefficient multiplied by net income or wealth (2). Arrow concluded that "broadly speaking, the relative risk aversion must hover around 1, being, if anything, somewhat less for low wealths and somewhat higher for high wealths" (2, p. 98). This conclusion is consistent with the King and Oamek finding of farmers with an absolute risk aversion coefficient of 0.000025 and a net income level of $40,000 (35).

Regarding such measures, Newbery and Stiglitz reached the following conclusion: "...most individuals are risk averse, but not very risk averse, and react to fluctuations in income rather than consolidating such changes into lifetime wealth. The coefficient of partial [relative] risk aversion typically increases from about 0.5 for small fluctuations in income (standard deviation about one month's wage) to about 1.2 for large fluctuations (standard deviation about 50 percent of annual income)" (48, p. 105). House reviews a number of other studies that found relative risk aversion coefficients for agricultural producers between 0 and 5.0 (28 p. 32).

Table 3 presents some examples of relationships between the coefficients described above. It shows possible combinations of absolute risk aversion coefficients, relative risk aversion coefficients, coefficients of variation of income, and relative risk premiums. All of these data are based on an assumed farm net income of $34,000.
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Table 3—Relationships between risk aversion measures

<table>
<thead>
<tr>
<th>Absolute risk aversion coefficient (a)</th>
<th>Relative risk aversion coefficient (az)</th>
<th>Coefficient of variation of income (CV)</th>
<th>Relative risk premium (RP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000029</td>
<td>1.00</td>
<td>0.33</td>
<td>0.054</td>
</tr>
<tr>
<td>0.000010</td>
<td>0.34</td>
<td>0.33</td>
<td>0.019</td>
</tr>
<tr>
<td>0.000040</td>
<td>1.36</td>
<td>0.33</td>
<td>0.074</td>
</tr>
<tr>
<td>0.000025</td>
<td>0.85</td>
<td>0.33</td>
<td>0.045</td>
</tr>
<tr>
<td>0.000025</td>
<td>0.85</td>
<td>0.66</td>
<td>0.185</td>
</tr>
</tbody>
</table>

1 Assumes a net income (z) of $34,000.
2 Note that $ \text{RP} = \frac{az(CV)^2}{2}$ (48, p. 73).

The first row of table 3 shows the risk aversion coefficients suggested by Arrow, a relative risk aversion of 1.0 implying an absolute risk aversion coefficient of 0.000029 at the assumed income level. The relative risk premium is algebraically equal to one-half the product of the relative coefficient of risk aversion times the square of the coefficient of variation of income (48, p. 73). This combination of farmer risk aversion and a coefficient of variation of income of 0.33 results in a relative risk premium of 0.054; in other words, returns from this enterprise are discounted by 5 percent in the farmer's decisionmaking. The second and third rows of table 3 show absolute risk aversion coefficients over the range found by King and Oamek, with the fourth row representing the midpoint of the King and Oamek range (35).

The last row of table 3 illustrates the importance of an increase in grain price variability of the magnitude described earlier in this report. Based on the measurements of price variability in the previous section, the standard deviation of prices may have doubled in the seventies, compared with the earlier period. Because net return margins are small and costs are relatively constant, a given percentage increase in the standard deviation of prices generally increases the coefficient of variation of income at least as much, or from 0.33 to 0.66 in this example. This increase in perceived price risk would increase the relative risk premium from 4.5 percent to 18.5 percent of net returns.

One additional risk aversion measure is useful herein—the concept of acceptable risk level described by Paris (51, p. 271). Consider the probability b with the economic interpretation that entrepreneurs are willing to accept a loss with (1-b) probability. The probability (1-b) is normally specified to be small, for example, 0.10. This is an appealing way of stating the risky production problem since the acceptable risk level (1-b), say 10 percent, may have a more intuitive meaning to producers and economic analysts than other risk-aversion coefficients.

Paris describes how the (absolute) risk aversion coefficient can be estimated as

$$a = - \frac{\tau (x'Vx)^{-\frac{1}{2}}}{2}$$

where a is the estimated coefficient, $\tau$ is a parameter corresponding to the acceptable risk level, x is a vector of observed production activity levels and V is the estimated net returns variance-covariance matrix for production enterprises (51, p. 273).

Table 4 presents examples of possible combinations of the various coefficients and parameters. Observe that either b must be quite low (0.60) or the coefficient of variation must be quite low (0.33) before absolute risk aversion coefficients and relative risk premiums become comparable with table 3 levels. Comparison of tables 3 and 4 suggests that b must be in the range of 0.60 to 0.80 to represent relative risk premiums that corres-

7 From the normal statistical distribution, 1-b proportion of events are more than $\tau$ standard deviations below the mean.

Table 4—Estimating the absolute risk aversion coefficient

<table>
<thead>
<tr>
<th>Coefficient of variation of income (CV)</th>
<th>Probability of no loss (b)</th>
<th>Normal distribution parameter ($\tau$)</th>
<th>Absolute risk aversion coefficient (a)</th>
<th>Relative risk premium (RP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.33</td>
<td>0.95</td>
<td>-1.845</td>
<td>0.000147</td>
<td>0.271</td>
</tr>
<tr>
<td>0.33</td>
<td>0.90</td>
<td>-1.282</td>
<td>0.000114</td>
<td>0.212</td>
</tr>
<tr>
<td>0.33</td>
<td>0.80</td>
<td>-0.842</td>
<td>0.000075</td>
<td>0.139</td>
</tr>
<tr>
<td>0.66</td>
<td>0.60</td>
<td>-0.253</td>
<td>0.000023</td>
<td>0.043</td>
</tr>
<tr>
<td>0.66</td>
<td>0.60</td>
<td>-0.842</td>
<td>0.000038</td>
<td>0.278</td>
</tr>
<tr>
<td>0.66</td>
<td>0.60</td>
<td>-0.253</td>
<td>0.000011</td>
<td>0.081</td>
</tr>
</tbody>
</table>

1 Assumes $x = 1,700$ units with net income of $20.00 each, so $z = 34,000$, and V = $43.56$ for CV = 0.33 and $174.24$ for CV = 0.66. The relationships are

$$a = - \frac{\tau (x'Vx)^{-\frac{1}{2}}}{2}$$

6 This example is an obvious simplification of the relationship between price variability and income variability. Income is a product of two random variables, price and yield; the impact of price variability on income variability, therefore, depends on the amount of yield variability and the correlation between yields and prices. The results reported later in this report recognize this relationship.
respond to the firm risk response results summarized in table 3.

To conclude this review of individual risk aversion measurements, it is likely that the risk premiums (discounts) that producers apply to high-risk enterprises are substantial. The seventies' increase in variability of world grain prices has likely induced U.S. farmers to adopt risk premiums of magnitudes large enough that they must be reckoned with in aggregate production response studies. Continued increases in grain price risks from variable world markets will likely induce farmers to apply even larger discounts to the returns from highly variable grain enterprises—discounts large enough to significantly affect aggregate production, resource allocation, and investment in agriculture. The next section looks at the possible aggregate supply response implications of this increased price risk and individual farmer risk responses.

### Impact of Increased Price Variability on Aggregate Supply Response

One of the primary analytical models supporting the world food study is ERS's U.S. Agriculture Sector Mathematical Programming Model (USMP). Producers' risk response is incorporated into the decisionmaking function using a mean-variance or \((E, V)\) risk formulation. The objective function of USMP maximizes the welfare measures of consumer surplus and producer surplus after accounting for risk. More specifically, USMP finds an agriculture sector equilibrium that maximizes the sum of three terms representing total expected utility: (a) the area under the demand curves, which represents consumer welfare, minus (b) the area under the supply curves, which represents all production costs, minus (c) the subjective value of the risk premium associated with risky enterprises, which is treated as a net return discount. The quadratic risk premium term in the objective function of this model is analogous to the aggregate absolute risk premium discussed above.

The firm level risk response measures reviewed previously were incorporated with an expected variance/covariance matrix of net returns so that USMP would represent relative risk premiums comparable with those shown in table 3; interested readers should refer to the USMP description for details (28). The primary USMP analysis was made with a risk aversion coefficient based on \(b = 0.80\); this level represents agricultural producers who, in the aggregate, are risk averse to the extent that they will accept a loss from an enterprise 1 year in every 5. From table 4, this value would generate a relative risk premium between 0.139 and 0.278 for coefficients of variation from 0.33-0.66. A dollar of returns from a risky enterprise would thus be discounted up to 28 cents when price variability is high. The primary USMP analysis thus portrays U.S. farmers as being, collectively, somewhat risk averse, with absolute risk aversion coefficients in the 0.000075-0.000038 range (third and fifth rows of table 4).

The USMP model was then used to perform sensitivity analysis on the impact of increasing volatility of export demands. Alternative levels of export demand uncertainty are simulated in the USMP model by modifying the net returns variance/covariance matrix used in the producer risk formulation section of the model. The original USMP risk formulation assumes that producers anticipate enterprise revenue variances and covariances corresponding to patterns of the sixties and seventies. By changing the variance/covariance matrix, the risk formulation of the model is changed to represent producer expectations for increasing net revenue variability in the enterprise. This is done by expressing the variance/covariance matrix as a function of mean commodity prices, mean regional yields, price covariances, and yield covariances. Mean prices and yields and yield covariances are estimated from historical data. Price covariances are a function of export covariances (estimated from historical data) and multipliers of commodity price changes resulting from given commodity export changes. The commodity price/export multipliers are estimated with the FAPSIM econometric simulation model (59). The enterprise net returns variance/covariance matrix is, in part, a function of commodity export variation. For this analysis, the revised variance/covariance matrix used in USMP is constructed to simulate the impacts of producers expecting double the interannual export variability (of cotton, corn, wheat, oats, barley, sorghum, and soybeans) which occurred in the sixties and seventies (27).

In many cases, the impact of increased interannual variability of exports becomes more pronounced as the average level of export demand increases. Ten USMP simulations were completed to explore this relationship (table 5). For example, table 5 shows total U.S. wheat production under each of the 10 simulations. The impact of a doubling of interannual export variability in

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8USMP is a partial equilibrium quadratic programming model of the U.S. agricultural sector (28).

9For an \((E, V)\) quadratic programming model, the absolute risk premium is \(2RP\) or \(a(x'Vx)/2\).

10The estimated relationships between export demand and commodity prices assume continuation of the existing farmer-owned reserved program.
Increasing World Grain Market Fluctuations

Table 5—Impact of export demand and variability on wheat production

<table>
<thead>
<tr>
<th>Average export demand</th>
<th>Expected interannual export variability</th>
<th>Historic 1970's variability</th>
<th>Double 1970's variability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Million bushels</td>
<td></td>
</tr>
<tr>
<td>Down 30 percent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1978 base</td>
<td>1,597</td>
<td>1,494</td>
<td></td>
</tr>
<tr>
<td>Up 30 percent</td>
<td>1,869</td>
<td>1,780</td>
<td></td>
</tr>
<tr>
<td>Up 60 percent</td>
<td>2,053</td>
<td>1,999</td>
<td></td>
</tr>
<tr>
<td>Up 90 percent</td>
<td>2,261</td>
<td>2,203</td>
<td></td>
</tr>
</tbody>
</table>

Wheat production is shown by the difference between the two columns.

Figure 2 shows the impact of a doubling of interannual export variability on equilibrium crop price and production levels. The impact of increased variability is represented by the vertical difference between the lines, for a given level of exports. For the exported crop commodities, increased export-demand variability leads to higher prices and lower production at all export-demand levels. When export-demand variability doubles, for example, the price of corn, soybeans, and wheat rises by 5–8 percent while their production falls by 3–5 percent. The simulated increases in demand variability cause increases in price and income variability for the export crops. Producers respond by cutting back production of these commodities whose returns are now more uncertain and hence discounted by risk premiums as discussed earlier. The relatively strong price increases that accompany these changes are due to the relatively inelastic demand for these commodities.

When export crop variability is increased in USMP, several opposing forces influence livestock supply functions and lead to slight increases in beef and dairy production and slight declines in pork production (fig. 3). Several forces lead to this result. First, since this scenario increases returns to risk in the export crop sector, there is a tendency to diversify, thereby reducing production of the increasingly risky crop commodities and increasing production of the less risky livestock enterprises. Second, livestock supply functions are heavily influenced by feed costs. Feed grain and soybean prices rise, tending to increase livestock production costs. However, the price of hay, a major expense of beef and dairy production, falls substantially and reduces livestock production costs. Wage rates also decline somewhat and the prices of minor feed grains decline relative to prices of major feed grains. For milk, fed beef, and nonfed beef, the net effect of these changes is slightly lower prices and slightly higher production. However, any gains from the higher production levels are more than offset by lower price levels such that these commodities' value of production and net returns decline. Pork shows the opposite impact: increased uncertainty leads to slightly higher prices and lower production. Hay is not an input in pork production and less substitution with minor feed grains is observed; hence the full impacts of corn and soybean price increases are felt. In all cases, impacts in the livestock sector are very small, averaging less than 1 percent.

Table 6—Shifts in U.S. commodity supply functions in response to doubling interannual export variability from the level of 1970's

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Change in price from doubling export variability</th>
<th>Change in production from doubling export variability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978 export demand levels</td>
<td>Export demand up</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Corn</td>
<td>4.8</td>
<td>5.0</td>
</tr>
<tr>
<td>Soybeans</td>
<td>7.6</td>
<td>10.5</td>
</tr>
<tr>
<td>Cotton</td>
<td>14.7</td>
<td>17.2</td>
</tr>
<tr>
<td>Milk</td>
<td>.7</td>
<td>-.6</td>
</tr>
<tr>
<td>Fed beef</td>
<td>-1.1</td>
<td>-.8</td>
</tr>
<tr>
<td>Nonfed beef</td>
<td>-1.0</td>
<td>-.9</td>
</tr>
<tr>
<td>Pork</td>
<td>1.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Percent
The USMP results show impacts after adjustments to a new equilibrium. Of the forces affecting livestock supply in this scenario, increased feed grain and soybean costs would come first, result in reduced derived demand for inputs, and then lead to reduced factor costs and factor substitution. The shortrun impacts of this scenario could well be small increases in milk, beef, and pork prices due to higher feed costs, followed eventually by small declines in beef and dairy prices as adjustments to the first round of effects take place.

Figure 4 presents the implicit crop commodity supply response functions for the two simulations of export variability. The supply response functions are simply the equilibrium price and production values corresponding to different demand levels. Supply response functions are relevant only for the scenarios from which they were generated—these simulations assume that export demand for all exported crops changes by equal percentage amounts. A different wheat supply response function, for example, would result if the simulation depicted rising export demand only for wheat. Another way of looking at this issue is to note that the impact of a shift in demand for corn will be different if the current price of soybeans is $6 per bushel versus $9 per bushel. The differences follow from both supply and demand side factors.

Table 7—Shifts in U.S. agricultural income and expenditures in response to doubling interannual export variability from the level of the 1970's

<table>
<thead>
<tr>
<th>Item</th>
<th>Change in income, expenditure items from doubling export variability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978 Export demand levels</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
</tr>
<tr>
<td>Gross agricultural sector income¹</td>
<td>-0.2</td>
</tr>
<tr>
<td>Total variable costs²</td>
<td>-1.4</td>
</tr>
<tr>
<td>Gross income less variable costs³</td>
<td>1.1</td>
</tr>
<tr>
<td>Return to producers⁴</td>
<td>33.8</td>
</tr>
<tr>
<td>Net farm income⁵</td>
<td>10.3</td>
</tr>
</tbody>
</table>

¹Value of crop and livestock production plus Government price support deficiency payments.
²Value of crops, livestock, and purchased inputs used in production.
³Gross income (row 1) minus variable costs (row 2).
⁴Row 3 minus ownership costs, depreciation, and imputed value of land use.
⁵An estimate of sector net farm income including income sources for commodities not included in the USMP model.

Table 8—Shifts in U.S. agricultural land and labor and selected input use in response to doubling interannual export variability from the level of the 1970's

<table>
<thead>
<tr>
<th>Item</th>
<th>Change in income, expenditure items from doubling export variability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978 Export demand levels</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
</tr>
<tr>
<td>Cropland use</td>
<td>-2.0</td>
</tr>
<tr>
<td>Pasture land use</td>
<td>.7</td>
</tr>
<tr>
<td>Labor use</td>
<td>-2</td>
</tr>
<tr>
<td>Fertilizer and chemicals</td>
<td>-1.9</td>
</tr>
<tr>
<td>Energy costs</td>
<td>-.6</td>
</tr>
<tr>
<td>Machinery and equipment ownership costs</td>
<td>-1.4</td>
</tr>
</tbody>
</table>

Percent
Crop Prices and Production Levels Under Alternative Export Variabilities

**Corn price**
Dollars per bushel

- Historical deviation
- Double historical deviation

**Soybean price**
Dollars per bushel

**Wheat price**
Dollars per bushel

**Cotton price**
Dollars per 480 pound bale

Export demand (percent) change from base level

-30% base level +30% +60% +90%
Livestock Commodity Prices and Production Levels Under Alternative Export Variabilities

Milk price
Dollars per hundredweight
- Historical deviation
- Double historical deviation

Fed beef price
Dollars per hundredweight

Nonfed beef price
Dollars per hundredweight

Pork price
Dollars per hundredweight

-30% base level +30% +60% +90%
Export demand change (percent) from base level

Milk is expressed in fluid equivalent.
Retail cut equivalent weight.
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and commodity mix of production. This shifts the implicit commodity supply functions upward, reducing output; but given the relatively inelastic total demand for agricultural commodities, prices rise sufficiently to increase revenue. The return to producers and net farm income increases by 33.8 and 10.3 percent, respectively, for the current export demand level. With export demand up by 30 percent, the uncertainty increases producer returns by 40 percent and net farm income by 12.3 percent. Farmers, however, are not better off since the increased income only partially compensates for the increased (subjective) cost of risk and uncertainty and leaves them with lower overall welfare level as represented by USMP. In general, consumers pay more on the average for less farm production when variability increases.

Table 8 presents the impacts of increasing export uncertainty on the use of various factors of production in the agricultural sector. There is less than a 2-percent decline in cropland use and a small increase in pasture land use. Labor use declines under increased variability, but by less than 1 percent in these export level scenarios. Fertilizer and chemical use decline by 1-2 percent and energy use falls by 0.5-0.9 percent due to increased uncertainty. Machinery and equipment ownership costs, a rough proxy for changes in demand for these items, fall by 1.1-1.4 percent.

Table 8

<table>
<thead>
<tr>
<th>Crop</th>
<th>Factor Use and Ownership Costs</th>
<th>1985-87</th>
<th>1975-77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>Cropland</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Fertilizer and Chemicals</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Cotton</td>
<td>Cropland</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>Pasture</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Labor</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Fertilizer and Chemicals</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>0.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Figure 4

Crop Supply Response Functions for Alternative Export Variabilities
Assuming Moderately Risk Averse Producers (b = 0.8)
For all levels of average U.S. agricultural export demand, the net value of exports increases when export variability is doubled. Since commodity prices rise, the quantities of exports fall. But, due to relatively inelastic demand, the net value of exports rises from 3.5-4.7 percent. Increased export demand uncertainty will result in greater year-to-year changes, but relatively small long-term impacts on U.S. balance of payments.

The above estimates are extremely dependent on the collective behavior of producers in response to risk and uncertainty, an attribute that is difficult to measure in the aggregate. The simulations described above were made with $b = 0.80$, an acceptable risk level of 20 percent. This assumption characterizes U.S. farmers as being moderately risk averse. This risk behavior must be viewed as assumed or hypothetical rather than measured; therefore, we repeated the model runs to see how the results and conclusions would be changed by an alternative, less risk-averse ($b = 0.60$), behavioral assumption, representing situations more like rows four and six in table 4. This situation portrays farmers, in the aggregate, as being only slightly risk averse.

This reduced risk-aversion assumption substantially lessens the impact of increased price uncertainty on the aggregate supply function (fig. 5). For the four major crops, the impact on the supply response function

---

**Figure 5**

**Crop Supply Response Functions for Alternative Export Variabilities Assuming Slightly Risk Averse Producers ($b = 0.6$)**

**Corn**

- Dollars per bushel
- Historical deviation
- Double historical deviation

**Soybeans**

- Dollars per bushel

**Wheat**

- Dollars per bushel

**Cotton**

- Dollars per 480-pound bale

---
Increasing World Grain Market Fluctuations

Table 9—Shifts in U.S. commodity supply functions from doubling interannual export variability from levels of 1970's under two risk-aversion assumptions

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Change in price from doubling export variability</th>
<th>Change in production from doubling export variability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1978 export demand</td>
<td>1978 export demand</td>
</tr>
<tr>
<td></td>
<td>levels 30%</td>
<td>levels up 30%</td>
</tr>
<tr>
<td>Crops</td>
<td>6.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Livestock products</td>
<td>-0.4</td>
<td>-0.2</td>
</tr>
<tr>
<td>Total</td>
<td>2.1</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Percent

b = 0.80 (moderately risk averse):

Crops 6.7 8.0 4.5 4.3
Livestock products -0.4 -0.2 0.2 0.0
Total 2.1 3.0 1.4 1.6

b = 0.60 (slightly risk averse):

Crops 2.2 2.7 2.0 1.5
Livestock products -0.2 -0.1 0.3 0.1
Total 0.7 1.0 -0.5 -0.6

Table 9 summarizes the supply function shifts under the two risk-aversion assumptions. With b = 0.80 (all farmers moderately risk averse), a doubling of export variability increases crop prices up to 8 percent and reduces livestock prices by 0.2 percent, for an average price increase of 3 percent when quantities are held constant. With prices constant, the quantity produced declines by up to 4.5 percent for crops, for an average reduction of 1.4-1.6 percent for all commodities modeled. With b = 0.60 (all farmers assumed slightly risk averse), supply function shifts are cut to less than half of these amounts. Price effects now average 0.7-1.0 percent higher for all commodities; with constant prices, quantities supplied are cut by 0.5-0.6 percent, as shown by the bottom part of table 9.

These results suggest that increased export market variability, given possible levels of farmer risk aversion, can have a significant impact on U.S. supply response for agricultural commodities. Doubling export market variability may cause average crop prices to increase by 7-8 percent to achieve the same level of production; or with prices constant, average crop production may decline by nearly 4-5 percent. Secondary effects of increased instability result in only small shifts in the supply functions of livestock products.

The assumed aggregate U.S. level of producer risk aversion has an important bearing on the estimates. The first part of this section reviewed some of the literature on producer risk behavior. The assumed aggregate acceptable risk level of 0.20 (b = 0.80) is certainly possible in the sense that empirical evidence does not reject such a hypothesis. However, alternative hypotheses also cannot be rejected, including the one that, in the aggregate, U.S. producers are risk neutral. With the assumption that producers are only slightly risk averse (b = 0.60), the supply impact becomes much smaller. If farmers are willing, in the aggregate, to accept a loss 40 percent of the time, market uncertainty will raise crop prices by only 2-3 percent and reduce crop production by only 1.5-2 percent. Such impacts would be of much less concern.

Other Impacts of Increased Export Variability on Agriculture

Increased variability in agricultural export markets, and the resulting increased farm price uncertainty and farming risk, has a number of additional impacts on the agricultural and food sector. The impact on soil conservation, the marketing sector, and consumers is summarized here. The important impact on the financial structure of the farming sector will be discussed later.

Uncertainty, Risk, and Conservation. A number of researchers have concluded that increased uncertainty lessens farmer use of soil conservation practices (1, 5, 12, 42, 75). Probably the most thorough treatment of the relationship between uncertainty and soil conservation has been provided by Ciriacy-Wantrup (13, 14). The general mechanism is that price uncertainty increases the discount rate that farmers use in decisions about conservation. This lessens their concern with soil conservation, making current income more important. Increased discount rates cause farmers to shift the use of resources from the more distant to the less distant future; in other words, conservation is discouraged. The increased risk premium in discount rates due to increased farm price uncertainty therefore will likely discourage the acceptance of soil conservation practices.

Many conservation practices, such as terracing and ditch lining, initially require substantial capital outlays,
while other practices may result in initial periods of reduced income. If farmers become more debt-averse to cope with the risk of unstable prices, then this adjustment can delay the adoption of conservation technology. Such technologies may require large capital investments which expose the farmer to excessive risks and cash flow problems when markets are variable.

Price Fluctuations and Marketing Costs. World grain market variability also has an important impact on the level of marketing costs. Binkley’s recent description of this phenomenon concludes that the inherent inflexibility of the international grain marketing system will generally worsen the effects of variability and lead to higher marketing costs. These increased marketing costs have special policy implications since the marketing benefits from stabilized trade volume and increases in marketing efficiency “...are potentially large and, in any case, are unequivocal welfare improvements” (7, p. 63). In contrast, other gains from price stabilization may cancel different elements of economic surplus and lead to mixed welfare results. Binkley concludes that a stable trade may reduce marketing costs significantly and that increased marketing costs should be included in any analysis of unstable international grain markets.

Other work has indicated that the variation in supplies of some commodities requires the marketing industry to vary its output over time, and to operate on the average at levels at which total unit costs are well above what they would be at design capacities (57, 75). In the long run, marketing industries simply pass on higher costs incurred as a result of increasing market fluctuations, either in terms of lower farm prices or higher retail prices or both.

Price Variability and Consumers. A recent USDA report on price and income instability also considered the impact of price instability on consumers:

Factors which produce farm price and income instability also cause domestic supplies and consumer prices of farm products to be unstable. That instability is costly to consumers because it forces them to make adjustments, both in the combinations of farm products purchased and in the shares of their incomes which they spend on farm products.

When there is a general shortage of basic food commodities so that their prices rise, the percentage of income which a consumer spends on food typically rises, and vice versa. For low and moderate income families, who spend a sizable share of their incomes on food in order to have an adequate diet, even when prices are low, the resulting variation in income available for nonfood purchases is large, as is variation in the real level of living.

Retail or consumer prices for foods and fibers are insulated to some extent from variation in domestic supplies and in farm prices by the cost structures of the market industries which transfer commodities from farms to consumers. In the past decade, farm to retail price spreads have been larger for most farm commodities than the prices received by farmers. However, spreads have changed relatively small amounts as supplies and farm prices changed. Therefore, for most farm commodities, the percentage variation in consumer price has been only half as large as the percentage variation in farmer prices.

(75, pp. 15-16)

The theoretical basis for arguing that consumers lose from price variability rests on the concept of diminishing marginal utility of income. Tweeten describes how variable prices reduce both consumer welfare and real income and reviews several studies providing evidence of such an impact (72, pp. 209-210). Since the marginal utility of income declines, the utility under stable prices exceeds the expected (average) utility under variable prices. Tweeten also argues that the loss in utility from unstable food prices causes consumers to shift consumption to items with less price variability, also reducing the demand for food.

Price variability for food and farm products results in income transfers among various groups—consumers, farmers, processors, exporters, and farm input suppliers. While these distributional impacts are important, summarizing the net impacts of price variability on different groups is quite difficult, beyond the above generalizations. Readers interested in pursuing this question further should refer to the voluminous literature on the subject (6, 27, 48).

Summary of Impact of Price Variability on Supply Response

Producer reaction to price variability and uncertainty is complex and empirical studies of how this adjustment affects supply response are few. Accurate measures of aggregate U.S. farmer risk response have not been
Increasing World Grain Market Fluctuations

made by any of these studies. Nevertheless, a thorough review of past literature and a sensitivity analysis using the USMP suggest that a doubling of variability in U.S. export demands may reduce aggregate production of U.S. agricultural products (27, 28).

The USMP suggests that the impacts of increased uncertainty increase with the level of exports and hence with total U.S. production levels. A doubling of interannual export demand variation above the level of the seventies may reduce production of major crops by 2-5 percent, or require increases in farm prices of 2-8 percent to elicit the same production. Shifts induced in livestock product supply functions by increased export market variability are much smaller, averaging about 0.2 percent. Therefore the weighted average production and price indices for all farm commodities are each changed by roughly 1-3 percent when export market variability is doubled. These USMP results appear consistent with the other studies reviewed in this report.

The increased variability in prices and the resulting declines in economic efficiency are also expected to increase marketing costs, make small increases in retail prices, reduce aggregate consumption, reduce consumer utility and real income, and lessen farmers' ability to adopt soil-conserving practices.

Price Variability and the Structure of the Farm Sector

The impact of export market fluctuations and the associated price risk and uncertainty create more problems for some farms than for others. The ability of farms to bear risk depends on several factors: size, equity ratios, debt loads, tenure, form of business organization, cost structure, degree of specialization, and commodities produced. Therefore, increasing price variability may have different impacts on different farms and, ultimately, on the structure of the farm sector. Increasing risk affects how different farms compete for resources, encourages some farm types and organizations, and discourages others. The level of risk and uncertainty is thus one of the determinants of who takes over the assets of existing farmers when they leave the sector, and is eventually one of the determinants of the structure and organization of the farm sector.

Table 10 suggests that the high coefficient of variation of farm prices prior to World War II was absorbed by a farm sector with production expenses, net farm income can now be more immediately affected by variations in prices received. This is because any change in prices due to market fluctuations has a greater impact on net income as the farm's use of purchased inputs and fixed-payment obligations increases. For example, with $100 in gross receipts and expenses of $70, a price decline of 10 percent reduces net income by $10, or 33 percent. But if expenses are $90, the same 10-percent price decline will cut net income by 100 percent.

As a result of the shrinking margin between gross farm income and production expenses, net farm income can now be more immediately affected by variations in prices received. This is because any change in prices due to market fluctuations has a greater impact on net income as the farm's use of purchased inputs and fixed-payment obligations increases. For example, with $100 in gross receipts and expenses of $70, a price decline of 10 percent reduces net income by $10, or 33 percent. But if expenses are $90, the same 10-percent price decline will cut net income by 100 percent.

Table 10 suggests that the high coefficient of variation of farm prices prior to World War II was absorbed by a farm sector with production expenses, including interest payments, of about 50 percent of gross income. This low ratio of production expenses to gross income provided a significant cushion, and net farm income could absorb a large amount of price variability. In the seventies and eighties, this same level of price
variability has again been reached, but now must be absorbed by a farm sector where production expenses are nearly 90 percent of gross farm income. Thus, U.S. farms are becoming more sensitive to fluctuations in market prices at the same time that these fluctuations are increasing because of greater dependence on foreign markets.

Table 10 also suggests that large farms with sales of over $200,000 may be less vulnerable to price risk than moderate-size or small farms. In 1982, farm production expenses were 75 percent of gross farm income on large farms, compared with 91 percent on moderate-size farms and 103 percent on small farms, indicating lower variation in the net farm income of large farms for a given level of price variation. This conclusion is supported by Tweeten who found that the relative variation in net farm income on large farms was considerably less than for small farms (71). The implications of this relationship for farm structure will be discussed later in this section.

Table 11 shows that the debt-to-asset ratio in agriculture has increased from 9.3 percent in 1950 to 17.8 percent in 1982. The ratio represents a substantial increase in the use of financial leverage in the last 30 years. It also means that cash requirements for annual debt servicing have increased; of course, higher interest rates on this debt have also increased interest costs. Based on average debt ratios, this annual cash requirement for debt servicing appears more important on larger farms than it is on small farms. Since nearly half of all farms have no debt, the rise in the average debt/asset ratio suggests an increased vulnerability of farms with debts, regardless of size.

Persistent inflation in the seventies also lessened the resilience of many farmers by causing cash incomes and expenditures to diverge from economic costs and returns (44, 45, 75). Total returns to the farm business investment did not change significantly, but increased farm prices and inflation increased expectations of farmers and resulted in substantial capital gains from land value appreciation. Land returns, in the form of appreciation, offset a portion of the annual returns from production, and this appreciation was exacerbated by income tax regulations and credit terms in the seventies. Thus while the total return to the farm investment remained constant, a decreasing portion of this return was made up of capital gains from land value appreciation. Although total economic returns remained largely unchanged by the inflation of the seventies, net cash incomes were seriously squeezed and are negative on some farms. This shrinking of farm operating income in relationship to the total investment and total returns has caused severe cash flow problems for many farmers.

### Table 10—Farm production expenses as percent of gross farm income, selected years

<table>
<thead>
<tr>
<th>Year</th>
<th>All farms</th>
<th>Farms with sales of:</th>
<th>Farms with sales of:</th>
<th>Farms with sales of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all farms</td>
<td>$200,000 and over</td>
<td>$40,000 to $200,000</td>
<td>less than $40,000</td>
</tr>
<tr>
<td>1935</td>
<td>53</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1940</td>
<td>62</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>1945</td>
<td>51</td>
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<td>NA</td>
</tr>
<tr>
<td>1950</td>
<td>60</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>1955</td>
<td>67</td>
<td>NA</td>
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</tr>
<tr>
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<tr>
<td>1983</td>
<td>83</td>
<td>74</td>
<td>86</td>
<td>99</td>
</tr>
</tbody>
</table>

NA = not available. Source: (76).

### Table 11—Debt/asset ratio for the farm sector, January 1, selected years

<table>
<thead>
<tr>
<th>Year</th>
<th>All farms</th>
<th>Farms with sales of:</th>
<th>Farms with sales of:</th>
<th>Farms with sales of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all farms</td>
<td>$200,000 and over</td>
<td>$40,000 to $200,000</td>
<td>less than $40,000</td>
</tr>
<tr>
<td>1940</td>
<td>18.953</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1945</td>
<td>8.9</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1950</td>
<td>9.3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1955</td>
<td>10.5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1960</td>
<td>11.8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>1965</td>
<td>15.1</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>1970</td>
<td>16.8</td>
<td>24.8</td>
<td>22.3</td>
<td>13.6</td>
</tr>
<tr>
<td>1975</td>
<td>16.2</td>
<td>27.9</td>
<td>18.6</td>
<td>8.5</td>
</tr>
<tr>
<td>1978</td>
<td>16.7</td>
<td>19.1</td>
<td>16.2</td>
<td>13.7</td>
</tr>
<tr>
<td>1979</td>
<td>16.1</td>
<td>16.0</td>
<td>15.2</td>
<td>13.1</td>
</tr>
<tr>
<td>1980</td>
<td>16.5</td>
<td>21.4</td>
<td>15.1</td>
<td>10.9</td>
</tr>
<tr>
<td>1981</td>
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<td>21.7</td>
<td>15.3</td>
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<td>1982</td>
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<td>23.9</td>
<td>17.2</td>
<td>12.3</td>
</tr>
<tr>
<td>1983</td>
<td>20.7</td>
<td>27.0</td>
<td>19.3</td>
<td>13.2</td>
</tr>
<tr>
<td>1984</td>
<td>20.8</td>
<td>27.4</td>
<td>19.1</td>
<td>13.3</td>
</tr>
</tbody>
</table>

NA = not available. Source: (76).
Increasing World Grain Market Fluctuations

The real world combination of institutional factors: inflation, capital gains treatment of certain returns, cash accounting, and credit terms cause the realized cash income portion of returns to shrink and the unrealized capital gains portion of returns to expand. By contrast, inflation causes the actual cash expenditures portion of costs to increase and the opportunity costs portion to shrink (because the opportunity costs are partially or completely offset by the capital gains returned to assets).

The result is that farmers are much less able to withstand price variability in a cash flow sense than they are in an overall economic sense. Even though long-run investment returns (operating income plus capital gains) remain favorable, inflation and changes in the organization of the farming sector in the seventies reduced cash income and lessened the resiliency of many farmers.

Finally, U.S. farmers continued to become much more specialized in the past three decades (22, 56, 75). This trend toward specialization has been particularly strong in wheat and feed grain regions, the primary regions producing for a variable world market. As a consequence, much of the traditional resiliency of a diversified farm sector has been lost. In its place are specialized wheat and feed grain farms dependent on the income of a single crop and completely vulnerable to the price risk of that crop.

The U.S. farm sector has thus seen its ability to deal with price variability and uncertainty lessened on three fronts: (1) increasing fixed contractual arrangements for production expenses, interest and debt service costs, land rental, etc., (2) cash income declining sharply as a proportion of total income, and (3) increased specialization and dependence on income from a single crop. Over time, U.S. agriculture is becoming less resilient due to smaller net cash income margins, which can be quickly eaten up by fluctuations in grain prices.

Arguments that Risk Retards Investment and Encourages Family Farms

With a given variation in income, the changes of farm survival decline as farm size is expanded with a fixed equity (table 12). With no borrowing (and hence zero leverage), a rate of return of 20 percent on capital of $100,000 provides net returns of $20,000. However, if $300,000 is borrowed at 10-percent interest (a leverage or debt/equity ratio of 3), interest payments are $30,000, gross returns $80,000, and net returns $50,000, sharply higher than with no leverage despite the same rate of return on capital (last column of table 12). However, in this situation, a negative return on capital of 20 percent, which caused only a $20,000 loss in the no-leverage situation, now causes a $110,000 loss. Since this loss exceeds the original equity capital of $100,000, the investor would be insolvent.

This specter of vanishing equity always haunts farmers. The severity of the problem is increased by either increased use of borrowed funds or by increased income variability and risk. The principle of increasing risk places "...a heavy restriction on firm size in agriculture" (26, p. 546).

Various forms of capital rationing result, all leading to less investment than would exist in the absence of uncertainty. Within the farm, farmers increase discount rates as uncertainty increases. This essentially increases the opportunity cost they assign to capital in investment decisions, and reduces their overall willingness to invest and the amount of capital invested. One logically expects internal capital rationing by U.S. farmers to increase with increasing price uncertainty.

However, external capital rationing—the response of lending firms to uncertainty—is probably more important in agriculture. Credit firms considering a farm loan take into account the same technical, technological, and market uncertainties that face the farm manager. For the lending firm, the principle of increasing risk represents the increasing probability that the borrower's security will be used up as leverage increases. Faced with increasing price variability and uncertainty, lenders therefore may limit the availability of farm capital. Moderate-size farms, particularly those with no source of nonfarm income, may find it increasingly difficult to finance farm expansion.

Table 12—Effect of increasing leverage on net return variation—the principle of increasing risk

<table>
<thead>
<tr>
<th>Leverage (debt/equity ratio)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>100,000</td>
<td>100,000</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Borrowed capital</td>
<td>0</td>
<td>100,000</td>
<td>200,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Total capital</td>
<td>100,000</td>
<td>200,000</td>
<td>300,000</td>
<td>400,000</td>
</tr>
<tr>
<td>Net returns @ 20%¹</td>
<td>20,000</td>
<td>30,000</td>
<td>40,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Net returns @ -20%¹</td>
<td>-20,000</td>
<td>-50,000</td>
<td>-80,000</td>
<td>-110,000</td>
</tr>
</tbody>
</table>

¹Gross returns (rate of return X total capital) less interest payments (10 percent X borrowed capital).

Source: (72).
Together, these arguments suggest that external capital rationing on the part of lending firms and risk aversion and internal capital rationing by farmers may significantly restrict the availability and use of capital in agricultural production and investment. This capital rationing may cause underinvestment in human resources, operating inputs, long-term capital investments such as land leveling, and farm expansion investments (72, p. 215).

Capital rationing by both lenders and farmers becomes more important as the level of risk and uncertainty are increased due to price variability in world markets. In a long-range structural context, farms may be hindered from reaching optimal size, long-term capital investments may be underfunded, and firm growth and investment in the agricultural sector may generally be retarded. Increased variability in the world grain market, based on these arguments, would be expected to retard farm size growth, investment, and efficiency in the U.S. agricultural sector.

Another concern with the structure and organization of the farm sector addresses the system of family farming that dominates U.S. agriculture. Some price variability is on balance favorable to continuation of the family farming system for a number of reasons:

- Family farms have proven to be flexible production units, able to supply highly variable needs for labor and management, able to adjust enterprise mixes, and able to adopt new technology rapidly and efficiently.

- Family farms with high equity have proven to be very resilient financial units because they have a lower proportion of their cost structure committed to cash expenditures and a higher proportion available as residual returns than do other forms of farm organization. This has helped them weather periods of unfavorable returns (75).

These arguments create the impression that family farming's comparative advantage over alternative forms of organization is enhanced by price variability.

The relationships behind this comparative advantage have been described by Raup. Writing about Government attempts to minimize the risk of low prices in U.S. agriculture, he stated that "the risk bearing capacity of the family-type farm is its greatest comparative advantage" (55, p. 307). Large-scale corporate and noncorporate farm firms must receive an annual rate of return on capital that is equivalent to the opportunity cost of this capital. Such firms must cover the full cost of all inputs out of each year's annual production income, or maintain large financial reserves to cope with variable markets. This situation is different with single-proprietor, family-type farms, where the operator typically owns a major part of the land and provides labor, capital, and managerial inputs. When faced with variable markets and low prices, the returns to these operator-owned inputs can be postponed until prices become more favorable, as long as basic family living expenses are covered.

Raup argues that this resilience of family farming, in an uncertain and variable economic environment, is one of the main factors preventing the U.S. agricultural structure from being dominated by large-scale, highly capitalized industrial enterprises. This argument suggests that the increased variability of world markets in the seventies strengthened the position of moderate-size, diversified owner-operated family farms, as compared with specialized, highly capitalized, highly leveraged industrial firms, financed with nonagricultural capital.

Larger farms have increased debt loads due to higher use of debt financing and leverage (table 11), which leads to increased vulnerability to income variations. Because variability of prices and incomes affects highly leveraged farms most severely, it tends to expose both new entrants and rapidly growing commercial farms to higher risks. Thus, while increasing price variability may impede the entry of young farmers into agriculture, at the same time it may increase their comparative advantage against highly leveraged nonfarm industrial firms entering the sector. The net impact of increased price variability on family farming in the United States is thus somewhat inconclusive.

Arguments that Risk Encourages Investment and Farm Consolidation

There is also basis for the opposite argument: that increased world grain market fluctuations and U.S. grain price variability may actually encourage both agricultural investment and larger farm size. Table 10 indicated that larger farms have lower production expenses in relation to gross income and therefore may be more resilient to price fluctuations. A number of economists have made other arguments leading to conclusions that variability tilts the balance in favor of increasing investment and farm size.

Robinson has hypothesized that capital investment in agriculture is positively related to price variability—the
ratchet theory of investment (58). He argues that a substantial amount of agricultural investment occurs in years of high prices since such years provide both the capital to invest and the incentive for farmers to invest and avoid high taxes. Thus it is possible for the sum of investments over a period of years to be greater with variable prices and incomes than with more stable prices. However, a study of the investment behavior of a sample of Minnesota farmers failed to provide conclusive evidence substantiating this hypothesis (19).

Additional background on the ratchet theory of investment is provided by Johnson and Quance (31). During favorable price periods, farmers expect continued favorable prices and make investments in land and machinery accordingly. These investments, however, are specialized farming investments and are not released to the nonfarm sector when prices drop; instead these resources are fixed in agriculture. Therefore price variability tends to increase investment over time and production continues high even when prices become unfavorable.

Tweetan offers another argument that price and income variability may increase investment in agriculture. "...if farmers consume out of their expected permanent income and save and invest out of the remaining, transitory income, variable income may result in a smaller permanent component used for consumption and a large residual component that is saved and invested in farming" (72, p. 215). This observation parallels or supports the ratchet theory of investment.

Extreme price fluctuations do provide the opportunity for those farmers to gain who (1) obtain large incomes during good years and (2) have the foresight or luck to time the reinvestment of this capital. Windfalls during good years are higher for highly leveraged farmers. Furthermore, Federal income tax laws underwrite a substantial portion of the risk for high-bracket farmers through cash accounting, income averaging, and loss carryforward and carryback provisions. For large farmers, such tax laws may significantly skew the distribution of aftertax income toward risk-taking investment and growth strategies. Such tax considerations would appear to amplify the ratchet theory of investment and encourage additional farm consolidation.

Some analysts have also argued that large farmers are better able to withstand variable income than family farmers (81). Clearly farmers with enough equity to allow them to borrow to cover production expenses and family living expenses are in a relatively good position when prices fall. These would include better established farmers and farms without land debt or farmers with considerable off-farm income, notably small farmers who get most of their income off the farm. However many moderate-size family farmers are not debt free and at the same time have relatively fixed living expenses that must be met. These farmers have a tough time paying bills and meeting basic family expenses when prices fall. Larger nonfamily farms, on the other hand, can shift profits to paying fixed costs when prices fall and can also borrow additional funds more easily because of their huge land assets. Price and income uncertainty also constitutes a barrier to entry for new farmers trying to finance land purchases, eventually leading to further consolidation of farms and absentee landownership.

Wessel also argues that large farms reduce risks through hedging, obtaining better information to reduce the uncertainty of future markets, forward contracting, storage and speculative stockholding, and other means. These are strategies not often used or not available to moderate-size family farms. Thus Wessel concludes that growing world markets and the resulting price variability are causing the moderate-size farm to disappear from U.S. agriculture, and to be replaced by larger-than-family, specialized, super farms financed by investors outside agriculture.

Lin and Ingerson used a statistical model of farm size, including a risk parameter, to estimate the effect of increased uncertainty on farm size (40). They concluded that large farms with sales over $100,000 are either unaffected by risk or actually benefit due to their advantages in dealing with risk. For moderate-size farms with sales of $40,000 to $100,000, the risk variable has no impact on the number of farms. However, for small farms, higher risk and uncertainty have the effect of decreasing numbers and reducing the shares of farm products produced. The statistical evidence provided by their analysis is quite significant; increasing instability causes consolidation of farms.

Increasing price variability in world markets also increases the need for reliable market information and forecasts and for sophisticated farm decisionmaking techniques to deal with uncertainty. While such information is provided by USDA situation and outlook activities, and can be supplemented by private farm management consultant assistance, increasing price variability and uncertainty also increases the incentive for farm firms to acquire their own information for decisionmaking. However, substantial economies of size exist in the production and acquisition of information, since it involves high fixed costs (82). Furthermore, information production is a risky enterprise, and information producers face both the possibility of producing
useless information, as well as the possibility of producing no information. As a result, a firm must be large enough to internalize the risk of losses from information production before it can produce information through its own data collection and analysis. This combination of high fixed costs and risk leads to substantial economies of size for information production; and these economies of size contribute to firm economies of size and industry concentration (47). Only large firms can afford to produce and effectively use information and this activity increases their efficiency, enabling them to become even larger; their advantage is enhanced as market variability and uncertainty increase. Large firms (created through both horizontal and vertical integration) therefore become more dominant due to information economies of size in an increasingly unstable agricultural sector.

Structural Change as an Adjustment to Risk

Some changes in the structure and organization of U.S. agriculture are clearly adjustments to risk. Certainly, adjustments to changing technology, markets, and policy conditions have been important in the changing structure of agriculture. However [these adjustments] also significantly changed the nature of risks and the level of risk exposure incurred in all stages of the subsectors. These new risks became structural change factors, triggering further adjustments oriented toward averting or minimizing risks. The general structural effect of these adjustments was to shift the decision centers of the subsectors away from the production stage to stages closer to the final product markets.

In the fourth stage, new strategies and institutions for risk aversion are developed: an increasing degree of vertical coordination, including heavy reliance on forward contracting; shifting control of product flows and characteristics from farm producers to the processing and marketing stages of the subsector; and a higher degree of industrialization of all stages of the subsector. (56, p. iv)

Consolidation in the agricultural sector by vertical integration (e.g., combining a farm and a processing plant) is of particular interest here. Vertical integration often reduces risk through the “portfolio effect” by spreading the risk among more enterprises; horizontal integration may sometimes increase risk in the same case. Therefore, increases in risk and uncertainty may encourage consolidation and industrialization through vertical integration.

Vertical integration and industrialization have been particularly important in some subsectors, including broilers, fed cattle, and processing vegetables. In the field crop subsector, hedging and forward contracting are increasing but have not become as important; Government risk-bearing institutions such as the disaster payments and crop insurance programs have been extensively used; and concentration of ownership and industrialization are less pronounced. It remains to be seen whether increasing grain market fluctuations will result in similar industrialization of the field crop subsector.

Other structural adjustments to increasing market risk and uncertainty are readily observable in U.S. agriculture. While diversification may not be increasing in general, it has been found to increase with farm size, suggesting that larger farms diversify to spread risk (52). Leasing of both machinery and land is an important means of avoiding increasing risk. Crop share leasing, where the landowner shares a portion of the cropping risk, also becomes preferred to cash leasing as agricultural risks increase. Risks are also shared through the use of business arrangements such as farm corporations, partnerships, and profit-sharing arrangements to involve additional persons in the business structure (75). Some farmers are able to stabilize their total income by off-farm employment (71). The current rise in part-time farms and off-farm income of farmers in general is likely being encouraged by the increasing variability in agricultural commodity markets. Many of these responses lead to an agricultural structure that is quite different from the traditional moderate-size, single-proprietorship, family-owned system.

Conclusions Regarding Structure

The research summarized above provides a somewhat mixed picture of the impact of market price variability and uncertainty on the structure of U.S. agriculture. An important question is whether increasing price variability and uncertainty encourage or discourage agricultural investment and consolidation of farms. Evidence and logic suggest conflicting conclusions (72, p. 215). The principle of increasing risk, capital rationing by lenders, and the hypothesized resiliency of moderate-size family farms all suggest that variability restricts investment and growth; while ratchet investment theories and the advantages large farms have for dealing with risk, including information economies of size, suggest the op-
Increasing World Grain Market Fluctuations

In our opinion, the net effect of instability on structure is more likely the latter: to encourage both investment and farm consolidation.

This conclusion is certainly defensible for the seventies. Even though world grain prices trended upward, accompanied by very large fluctuations around the trend, U.S. price support programs eliminated much of the risk of low grain prices. Thus, farmers may have perceived the increased price variability of the seventies as an increased likelihood of a very high price, with no prospect for a corresponding low price. This asymmetry of expectations caused by the price support programs likely encouraged speculative investment and farm consolidation in the seventies beyond what would have occurred without such programs. In the future, the strength of this response will depend to some extent on the nature of these “safety net” policies, the topic of the next section of this report.

In a narrower context, some conclusions are more clear. Price variability and uncertainty encourage diversification, leasing, more complex business forms, off-farm income, part-time farming, forward contracting, and vertical integration. Except for diversification and the growth of part-time farms, the general effect of these adjustments is to shift decisionmaking away from the production stage and to promote a higher degree of industrialization in the farming sector.13

Market Fluctuations and U.S. Grain Policy

Increased world grain market fluctuations reduce efficiency and may lead to speculative investment and concentration in the U.S. agricultural sector. While the private sector can adjust to this variability, the consequences are bothersome to many, both farmers and nonfarmers alike. Since inefficiency increases food prices, the public has an interest in maintaining agricultural efficiency and perhaps in influencing structural change. There is therefore concern about policies that reduce price variability, share the burden of market fluctuations, or ameliorate the impact of price risk and uncertainty.

As discussed earlier in this report, cyclical economic activity, interest rates, and balance of payments problems in other countries all get registered through floating exchange rates in the grain prices received by U.S. farmers. All are sensitive to U.S. macroeconomic policy. These macroeconomic factors are likely to cause important cyclical (multi-year) shifts in the demand for U.S. grain exports and must be considered in any discussion of U.S. agricultural policy in the years ahead. The focus in this section, however, is on year-to-year variation in the grain market and the related impacts of grain policy.

Policy to deal with market fluctuations must recognize two emerging features of U.S. agriculture. American agriculture is much different now from what it was 30 years ago when exports consumed only a small share of grain production and the U.S. farm sector was a closed economy. Then, agricultural policy was generally concerned with low income and returns, and could be considered in isolation. However, the increased importance of grain export markets, up to two-thirds of the wheat crop and almost one-third of the corn crop, have made the United States an open participant in the world grain market. As a consequence, policies that stabilize or support U.S. prices also stabilize and support world markets (9, p. 310). The United States is large enough in the world grain market to absorb much of the variability if it so chooses. However, since programs to mitigate variability now must do so in the context of the world grain market, they are less effective and much more costly than the price support policies of the fifties and sixties. Thus, while instability is expected to reduce efficiency and accelerate structural change, the public cost of mitigating these effects with traditional programs will also be greater, and hence more controversial.

A second emerging feature is that the U.S. farm sector is becoming increasingly polarized into two subsectors. The efficient commercial farm subsector can compete effectively in the world market and earn competitive returns and adequate operator incomes. This is in sharp contrast with the other subsector, composed of a large number of small farms, where operator incomes derive largely from nonfarm sources, and where resource returns are low. Severe cash flow problems face some of these small farms as well as new or expanding commercial farms, and these cash flow problems are magnified by market fluctuations. This polarization restricts what can be accomplished by present grain policy where benefits are proportional to production:

- The justification for price supports that transfer income to large commercial farms is being increasingly questioned.

13These distributional or structural impacts of increasing grain price variability—speculative investment, concentration, and industrialization in the farm sector—should not be interpreted as increasing capacity or productivity. For example, speculative investment in land may diminish efficiency if it displaces skilled farm operators.
• Policies to deal with instability in the commercial farm subsector do not address the cash flow or income problems of small farms, since their low grain production levels provide few program benefits.

Recent U.S. Grain Policy

The central theme of U.S. grain policy throughout the last three decades has been to support grain prices at politically acceptable levels. This meant that in most years, the U.S. price support was above the world market-clearing price. Consequently, U.S. production exceeded demand and stocks accumulated. The stockpiles were then worked off by production control programs and consumer (mainly export) subsidies. An implication of the price support strategy was stability of grain prices in the United States and abroad. World prices followed near the U.S. loan rate (plus transportation charges) most years during the fifties and sixties.

In the early seventies, U.S. and world grain prices rose well above U.S. loan rates. By the late seventies, however, rising loan rates met falling grain prices and again world market price support was provided by the U.S. price support program. The fact that U.S. loan rates were below market prices during the seventies is evidence of a sharp increase in world market demand and not of a primary change in U.S. grain policy.

Many grain policy instruments have been used over the last 30 years, even though price support objectives remained essentially the same. Some names of the instruments have changed with changes in administrations. Since 1977 the grain policy instruments have been:

- Price support—nonrecourse loan program
- Government ownership of grain—Commodity Credit Corporation (CCC)
- Production control—set-aside, reduced acreage program, payment-in-kind program
- Deficiency payments—target price
- Subsidies to private grain storage—farmer-owned reserve, subsidized loans for construction of storage facilities
- Export promotion—subsidies, blended credit, P.L. 480
- Government sharing of producer risk—crop insurance, disaster payments, emergency low-interest loans tax relief

The U.S. market price is basically supported by a nonrecourse loan program where farmers may use their grain as collateral to secure a loan from the Government. When the loan matures, the farmer has the option of either paying off the loan or giving the grain to the Government. The Commodity Credit Corporation takes over ownership when market prices are low and farmers can pay off their loans with grain instead of cash. The loan rate—the amount of money loaned per bushel of grain—thus acts as a price floor to the farmer and to the market if a large quantity of grain is under loan.

Diversion of cropland from grain production (under various program names) has been used many times to reduce the surplus of CCC-owned and privately owned stocks. The PIK program in 1983, for example, reduced grain acreage substantially below 1982 levels. Attempts have also been made to boost exports using low-interest credit and subsidies targeted to selected countries. In most years prior to 1973, export subsidies were used to promote grain exports.

Two of the most recent additions to the policy toolkit have been deficiency payments in 1973 and the farmer-owned reserve in 1977. Though initially conceived as major departures from the historical price-support strategy, they have been administered as though they were price-support instruments. Deficiency payments were initially rationalized as direct income payments to producers, the most efficient way to support producer incomes. In most years, however, they have been administered as if they were cropland diversion payments. The farmer-owned reserve was viewed by economists as a tool designed specifically for reducing price variability, with little impact upon the average price level. But it has in fact been administered mainly as a substitute for CCC ownership of surplus stocks and thus has evolved into a price support tool (67).

Besides programs to help support grain prices, the Government has shared other production risks with producers by subsidizing crop insurance, providing disaster payments, and making available low-interest loans when crops failed. It has provided tax relief (not limited to farmers) such as income averaging, which helps spread the cost of losses over several years. The Agriculture and Food Act of 1981 also initiated a study of income or revenue insurance, a type of all-risk crop insurance to cover price, as well as yield variability (15, 63).

International trade negotiations are an important factor in the U.S. policy response to worldwide grain market variability. The U.S. position in multilateral negotiations has been to lower trade barriers and make a larger share of the world's producers and consumers responsive to world prices. Likewise, one objective of the bilateral agreements with the Soviet Union has been to reduce year-to-year variability in Soviet grain purchases.
Grain Policy Alternatives

In 1985, the present grain policy instruments and strategies could be left intact, much as they have been since 1977, or some major changes could be made. Four alternative policy directions are discussed here. There are other possibilities, but these four illustrate the most important linkages between U.S. policy and price variability in world grain markets. They are:

1. High price supports with large public stocks
2. High price supports with low public stocks
3. Low price supports with private stocks only
4. Low price supports with public stock supplements

By high price supports, we mean a grains policy intended by policymakers to support U.S. and world grain prices most of the time. This means that policymakers expect the corn loan rate (for example) to be high enough to support the world corn price and force corn stocks to accumulate in at least 7 years out of 10. In contrast, by low price supports, we mean a level of price support that would support world grain prices less than 2 years out of 10. Such support levels would of course need to be adjusted over time to reflect structural changes in the macroeconomy and grain markets.

The relative impacts of the four policy alternatives on market prices and quantities are shown in figure 6. Panel A represents high price supports with large stocks, Panel B represents high price supports with low stocks, and Panel C represents low price supports. In each panel, line D represents grain demand (domestic plus export demand), curve D_T represents demand (D) plus the demand for yearend stocks by both the private sector and Government. When prices are low, grain owners sell less and carry larger inventories into the next year; hence D_T deviates further from D as price declines. Line S_T represents the total supply of grain at the beginning of a marketing year, production (S) plus beginning stocks. With stocks, the annual supply and utilization balance is represented by the intersection of S_T and D_T, such that beginning stocks plus production equals demand (utilization) plus yearend stocks. If stocks are constant, the market-clearing price P would balance annual production and demand.

Curve D_T becomes horizontal at the loan rate, P_L, because of the dynamics of private and public demand for ending stocks. At P_L the demand for yearend public stocks is perfectly elastic because of the nonrecourse loan. The Government through the CCC is willing to take ownership of all grain offered (and under loan) at the loan rate. If the market price were above P_L, there would be some private demand for stocks but no CCC demand. The farmer-owned reserve would make the demand for ending stocks more complicated than shown, but the basic concepts would still hold. The supply and demand curves in figure 6 are assumed to represent the average conditions expected over several years.

High Price Supports—High Stocks. The high price support refers to the level of the loan, P_L; all price support instruments available since 1977 are assumed to remain in use in this case. The loan rate is assumed to support the U.S. (and world) grain price in a typical year. The market clears at the price support level P_L with the quantity Q_S being supplied, Q_D being consumed domestically or exported, and Q_S - Q_D representing the level of yearend stocks. Most of these...
stocks are Government owned or subsidized because there would be little incentive for private stockholding (discussed below). As long as $P_L$ is above the equilibrium market-clearing price (where production equals demand with no change in stocks), CCC stocks will increase to support the price at the loan level, and yearend stocks will exceed beginning stocks. This result is illustrated by production ($S$) which is greater than $Q_D$ but less than $Q_S$.

Note that in any one year there could be a substantial increase in export demand (shifting $D$ and $D_T$ right) or a low crop yield in the United States (shifting $S$ and $S_T$ left) and the price would remain at $P_L$. This shows how the United States could effectively absorb shocks to the world grain trade, stabilizing market prices near $P_L$; the large quantity of stocks carried by the United States absorbs any shocks.

This situation represents market conditions common during the fifties and sixties. If price support levels are kept high, very large quantities of grain end up in Government ownership. Even though large quantities of land were diverted from grain production during the sixties, stocks were still large enough to absorb most shocks to the world market.

**High Price Supports—Low Stocks.** The United States could have a high price support without intentionally accumulating Government stocks. This could be done by tightly restricting production and thereby total supply to, say, $S_T'$, so that under normal circumstances Government stocks would not accumulate. (To simplify the figure, annual production $S$ is not shown here.) Total demand, $D_T$, is the same as before. Government stocks would still accumulate at prices near $P_L'$. However, the smaller total supply, $Q_S'$, would reflect reduced production and reduced beginning stocks and would cause the market to clear at price $P_B$, which is above $P_L'$. Total consumption, $OQ_D'$, would be slightly less than $OQ_D$ above but yearend stocks would be reduced to $Q_S' - Q_D'$—much less than the case without production control. Most of these stocks would be privately owned. Stocks would grow if the reduction in production was not enough to bring $P_B$ above $P_L'$; however, strict production controls could always be used to reduce stocks.

The lower stock level would restrict the U.S. ability to absorb shocks to export demand or domestic production but it would substantially reduce Government and private grain storage costs. A poor U.S. yield or a poor crop abroad would generate higher prices in the short run than with high price supports and high stocks.

**Price variability in the world market would be greater because of the reduced stocks.**

This policy represents an aggressive stance by the United States to use its market power to raise world grain prices and to reduce its role as the world’s shock absorber. However, the Government would have to enforce severe production controls on U.S. farmers to avoid stock accumulation.

**Low Price Supports—Private Stocks.** In the third policy alternative, low price supports with only private stocks, the price support, $P_L''$, is set low enough to be below the world price $P_C$ in most years. In the short run, this lower price support would increase export demand as represented by movement down along the demand curve. It could also lead to a longrun structural increase in export demand because it would enable the United States to exploit its competitive advantage and expand the size of its productive plant with respect to other grain-exporting countries. This expanded longrun demand is shown by the shift in demand from $D$ to $D''$. The market clears in the typical year at price $P_C$—above the support price. The total quantity consumed and exported, $OQ_D''$ exceeds the other two examples. Ending stocks of $Q_S'' - Q_D''$ fall between the other two examples. These stocks would be all privately owned, as discussed below. Annual shifts in supply and demand would cause price variability but some private stocks would be available to partially absorb those shocks. Average grain prices would be lower than with the other two alternatives and Government program costs would be substantially reduced.

A policy of intentionally low price supports and stocks implies a major reduction of Government intervention in both supporting grain prices and reducing price variability. Adjustments to grain market fluctuations would be left primarily to the private sector.

The private sector stores grain expecting to make a profit. Price variability (actually, the expectation of price increases) provides profit opportunities. Gardner and other economists have shown how competitive storage can reduce price variability in the United States and, consequently, in the world (18). Stockholding tends to increase prices in surplus situations and reduce prices during shortages. Price must be expected to increase by at least the cost of storing grain to induce producers to store rather than sell. Storage and interest

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14The low stock level in the United States could also induce importing countries to put more emphasis on self sufficiency. If so, demand for U.S. exports would decrease, shifting $D$ and $D_T$ to the left in Panel B.
costs for storing grain a whole year are about 20–25 percent of the value of the grain (using 1983 rates). On-farm storage in existing bins costs about 15–20 percent of the grain's value. Substantial price variability is needed to offset these costs and induce storage from one crop year to the next. As a result, private sector stockholding results in only small reductions in grain price fluctuations and both research and public debate suggest average private stocks are generally less than the optimal level from society's standpoint (16).

**Low Price Supports—Public Stock Supplements.** The competitive grain industry (including producers) is more efficient in holding stocks when accurate world market information is available. To assist that need, the Government provides accurate and timely worldwide market information at little or no cost to users. This information helps grain owners allocate grain between one crop year and the next.

Numerous policy incentives can also be used to supplement or increase private stockholding, and further reduce price variability. Government stock ownership and subsidies to private stockholding have been used to increase the average quantity of stocks held, further reducing price variability. But the public costs under present programs tend to be high. A key component of the effectiveness of public programs to supplement private stockholding is the interaction between Government and the private storage industry. Since 1960, ending grain stocks in the United States have shown considerable variability (figs. 7 and 8). Since the late sixties, most stocks have been privately owned. Government-owned stocks were large in the early sixties but relatively small since. Most of the privately owned stocks however, received some subsidy. Farmers usually obtained low-interest nonrecourse loans on their stored grain. Low-interest storage construction funds were also available. Since 1978, large quantities of grain were placed in the farmer-owned reserve with the Government subsidizing storage and interest costs.

Much has been learned from the U.S. experience of Government interaction with private stockholding. The main conclusions are:

- A bushel of grain in Government storage increases total stocks by only a fraction of a bushel because private stocks are displaced.

- Government costs of adding 1 bushel, on the margin, to total stocks are quite high. Gardner estimates that 4 bushels in the farmer-owned reserve add 1 bushel to total stocks (78). With a storage-plus-interest subsidy of about 50 cents per bushel, the cost of adding one more bushel to stocks for a year was about $2.00. Estimates by Sharples were somewhat lower, although Government costs were still high (67).

**Figure 7**

**Wheat Production and Ending Stocks, United States**

Million metric tons

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Total ending stocks</th>
<th>Government-owned stocks</th>
<th>Farmer-owned reserve stocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>30</td>
<td>40</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>1955</td>
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<td>1980</td>
<td>60</td>
<td>100</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

Marketing year
Government management of stock-related rules can itself generate uncertainty in the market, offsetting the stabilizing influence of the Government stocks. For example, the rules and parameters of the FOR have changed many times (67, pp. 36-38). Uncertainty about future rules changes may further discourage private stockholding.

Thus, the benefits from Government intervention in grain storage have come at substantial cost. However, coupled with low price supports, some stockholding incentives may be effective. The literature on price stabilization through buffer stocks is voluminous (6, 48, and 78 provide literally hundreds of citations) and suggests or evaluates many policy prescriptions. A simple subsidy to stockholding, say 20 cents per bushel per year, may be a more efficient way to promote price stability. Such a subsidy may be preferable to the current complicated system of price supports and triggers, CCC-loans, and the farmer-owned reserve (18, Ch. 6; 66). In terms of panel C of figure 6, such a subsidy would shift $D^*$ to the right, but without the complications of the price support loan and Government-owned stocks. Of course the existence of a low-level price support (1-year nonrecourse loan program) could also complement this storage subsidy program.

Unfortunately, no experience exists on operating such public incentives to stockholding in conjunction with low price supports. The issues are complex but appear to warrant attention by both economic analysts and policymakers.

Some advocate a fifth option. That option would be to support the domestic grain price to producers and domestic consumers at a level considerably above the expected world price, tightly control production, and export any excess production above domestic needs using an export subsidy. Since the domestic price would not vary, there would be no incentive for privately held stocks other than for pipeline needs. This approach approximates the grain policy of the European Community except for the production control. It would provide very stable domestic U.S. grain prices but it would also cause greatly increased price variability in the world market for two reasons. First, the United States would no longer be the world’s shock absorber. And second, U.S. production variability would be totally transmitted onto the world market.

This alternative would mean very strong Government control, and high costs to the U.S. Treasury, and would generate instability in international relationships as well as in world grain markets. Retaliatory trade measures by other countries could even mean eventual loss of U.S. export markets and foreign exchange. Each of these implications goes against traditional U.S. policy objectives.

Figure 8
Coarse Grain Production and Ending Stocks, United States

<table>
<thead>
<tr>
<th>Million metric tons</th>
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</thead>
<tbody>
<tr>
<td>300</td>
</tr>
<tr>
<td>250</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>150</td>
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</tr>
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<td>50</td>
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</table>

<table>
<thead>
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<th>1950</th>
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<th>75</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Total ending stocks</td>
<td>Government-owned stocks</td>
<td>Farmer-owned reserve stocks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Marketing year
Increasing World Grain Market Fluctuations

Who Gains and Who Loses?

Some groups would gain and others would lose if the United States chose one of the four policy strategies. The increased price variability associated with low price supports (and with high price supports with low stocks) would increase risks to producers and create other social costs. But tradeoffs go well beyond the issues associated with producer risk and farm structure. Table 13 helps identify gainers and losers.

High Price Supports—High Stocks. A high level of price supports, with the Government loan rate above expected U.S. and world grain prices in most years, would add stability to both U.S. and world grain markets. However, this policy reduces exports and leads to large Government-owned grain stocks. Government storage and price support costs would be high (table 13).

U.S. grain producers would appear to be better off with the high price support alternatives because of the higher average grain prices. But this is not true for all producers; the higher returns would tend to be bid into land prices so that current landowners would reap most of the benefits. Land renters would pay higher rents, offsetting most of the additional income generated from the high price supports. Large commercial farms would receive windfall gains from high price supports because of low sales volume. Small farms would receive few benefits from such price supports because of low sales volume. The higher land values would represent an added barrier to expansion of small farms.

The nonagricultural sector of the economy would also be affected. Consumers would pay higher food prices with price supports. Higher grain prices would also lead to higher livestock and meat prices.

The U.S. policy choice would have a significant impact upon countries that buy or sell grain on the world market. Since the U.S. trade volume is so large, the policy choice would directly affect world market prices. High price supports with large stocks would mean relatively high-priced grain to importers, but more stable prices. Producers and consumers in many importing countries are not directly affected by world grain prices because their governments set the prices. They are indirectly affected, however, through adjustments in their trade balances, exchange rates, taxes, and inflation. Other grain-exporting countries would benefit from high price supports in the United States. They could increase their volume of exports knowing that the United States would support the world price at a relatively high level.

High Price Supports—Low Stocks. Large Government-owned stocks could be avoided through production controls, even with high price supports—the second column of table 13. However, many farmers would view the strict production controls as unacceptable. The lack of stocks would increase price variability in residual U.S. and world markets, although the negative impact of this variability on U.S. farmers would be ameliorated to an extent by the high price supports. Government program costs would remain high if production were controlled through voluntary incentives.

Landowners and large farms would also benefit under this alternative. To be effective, production control programs must focus on large farms, with large payments for voluntary participation. The competitive advantage of large farms over small farms is generally still enhanced.

High price supports with low stocks would lead to relatively high and variable grain prices in world trade. This would be the least desirable alternative for grain importers because they would need to use more foreign exchange for grain imports plus they would be forced to make adjustments to absorb greater world market variability. This could push developing countries to borrow more when grain prices were high, to strive for self-sufficiency, or to carry more stocks.

Low Price Supports—Private Stocks. Low price supports, with the Government loan rate below expected market prices most of the time, would provide some protection to farmers against price collapse in the world market. Price variability would be high (table 13) and the increased uncertainty would lead to some inefficiency in U.S. production. However, Government costs

<table>
<thead>
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<th>Item</th>
<th>High price supports</th>
<th>Low price supports</th>
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</thead>
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<tr>
<td>Average grain price level</td>
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<td>low</td>
</tr>
<tr>
<td>Expected price variability</td>
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<td>medium</td>
</tr>
<tr>
<td>(U.S. and world prices)</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Volume of grain production</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Volume of grain in storage</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>U.S. grain export volume</td>
<td>high</td>
<td>medium</td>
</tr>
<tr>
<td>Government program costs</td>
<td>high</td>
<td>medium</td>
</tr>
</tbody>
</table>

Table 13—Impact of U.S. grain policy alternatives
would be reduced and U.S. farmers could expand their share of world grain exports, benefiting input suppliers, grain-marketing firms, U.S. consumers, taxpayers, and grain-importing countries.

Suppliers of farm inputs would generally prefer the alternative that leads to the highest volume of production: low price supports. That alternative would mean higher sales of fertilizer, seed, and other inputs. Suppliers of management services and information services to producers also would likely prefer low price supports. With more price variability facing the producer, there would be more demand for management assistance and market information. Firms that transport, process, and market grain would prefer the higher volume of grain from low price supports because their profits depend upon volume.

The substantial reduction in price supports would reduce the equity of current landowners. Farms facing cash flow difficulties would be disadvantaged by this option in the short run, but in the long run reduced land values may lower debt service costs of beginning and expanding farms, and reduce other problems faced by this subsector. Low price supports would provide some protection to commercial agriculture—the most efficient farms—from the risk of world grain market fluctuations. The protection could help defend this sector from less efficient, but possibly more resilient farm types, such as part-time tax-loss farming. The net result of such structural implications is, however, difficult to predict.

The U.S. balance of trade would be improved by low price supports because of the increase in export earnings from grain sales. The increase in exports would more than offset the decrease in price (i.e., longrun export demand is elastic, 63).

**Low Price Supports—Public Stock Supplements.** The high price variability under the low price supports could be reduced by Government incentives to private stockholding and occasional CCC stocks. Such policies would increase the average volume of grain in storage, but also increase Government costs (table 13).

The costs and problems associated with extreme grain price fluctuations could be reduced by this alternative, while maintaining high production levels, export markets for U.S. farmers, and the other benefits associated with low price supports. However, Government costs are also increased. There is little information available to suggest the best level of stocks or public subsidies to stockholding. And there is little assurance that the benefits of such a policy mix would exceed the cost to the Government. Nevertheless it may be a viable alternative.

**Summary of Policy Tradeoffs**

In the long run, those who would lose by switching from high price supports to low would be (1) current owners of U.S. cropland, and (2) competing grain-exporting countries, mainly the grain producers in those countries. Gainers from low price supports would be U.S. consumers, U.S. taxpayers, input suppliers, grain marketing and processing firms, and grain-importing countries. Many U.S. grain producers might also be no worse off as long as they were not large landowners. Finally, the level of Government intervention in grain production would be reduced.

Low price supports would do less to offset increased price variability than high price supports with large stocks. This greater price variability could magnify the impacts discussed earlier in this report: a small decline in the aggregate U.S. production efficiency of grain crops, and possibilities for increased concentration in the structure and organization of U.S. agriculture. Public programs and incentives are possible to increase stockholding under low price supports. However there is little experience with such programs and little information is available on their potential cost effectiveness.
Increasing World Grain Market Fluctuations

References


Increasing World Grain Market Fluctuations


(73) University of Minnesota. "On the Record: Are We Blighting the Land that Feeds us?" Corporate Report, June 1982.


The hog industry has moved rapidly in the last 30 years from barnyard sideline to mechanized million-dollar operation. This report describes the most prevalent practices used today. Includes confinement production facilities, breeding, feeding regimens, waste management, and more. Charts, photos, and 54 detailed appendix tables.


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