International Agricultural Trade
Research Consortium

Global Grain Stocks and World Market Stability Revisited

by

Steve Martinez and Jerry Sharples*

Working Paper # 91-5

The International Agricultural Trade Research Consortium is an informal association of University and Government economists interested in agricultural trade. Its purpose is to foster interaction, improve research capacity and to focus on relevant trade policy issues. It is financed by the United States Department of Agriculture (ERS, FAS, and CSRS), Agriculture Canada and the participating institutions.

The IATRC Working Paper series provides members an opportunity to circulate their work at the advanced draft stage through limited distribution within the research and analysis community. The IATRC takes no political positions or responsibility for the accuracy of the data or validity of the conclusions presented by working paper authors. Further, policy recommendations and opinions expressed by the authors do not necessarily reflect those of the IATRC.

This paper should not be quoted without the authors' permission.

*Steve Martinez and Jerry Sharples are Agricultural Economists with the Agricultural Trade Analysis Division, Economic Research Service, U.S. Dept of Agriculture. Special thanks to Praveen Dixit for many helpful suggestions. Thanks go also to Ann Hillberg-Seitzinger and Vernon Roningen for constructive comments. Correspondence should be addressed to:

Steve Martinez
USDA, ERS, ATAD
1301 New York Ave., N.W. Room 624
Washington, D.C. 20005-4788

ABSTRACT

The world's grain stocks are providing more world market stability than they did prior to 1978. Even though the volatility of world grain production increased since 1978, global consumption volatility declined. Grain production variability in the Soviet Union, United States, and Argentina appear to be major potential sources of instability to world grain markets, though much production variability in the Soviet Union and the U.S. is offset by their own stock adjustments. U.S. stocks have played a major stabilizing role on world grain markets. EC grain stocks in recent years have also played a stabilizing role. Reductions in U.S. and EC grain stock levels, a possible result of trade liberalization talks, could have important implications for market stability in the future.

GLOBAL GRAIN STOCKS AND WORLD MARKET STABILITY REVISITED[1]

Steve Martinez and Jerry Sharples

INTRODUCTION

In the late seventies and early eighties, many studies examined world grain market stability and grain stocks issues (Houck and Ryan, 1980; Blandford, 1983). These studies were in response to grain shortages and the increase in grain market volatility in the seventies. They generally concluded that world grain price volatility was excessive due to suboptimal management of the world's grain stocks. Further, the forces creating that volatility were not expected to diminish in the future. Various national and multinational solutions were proposed either to improve management of stocks or to reduce other destabilizing forces affecting world grain markets. Several studies further suggested that only a few countries--mainly the U.S.--used their grain stocks in a way that adds stability to world grain markets (Josling, 1980; Sharples and Goodloe, 1984).

As global grain stocks grew in the eighties, interest in the topic waned. Now, after nearly a decade, interest in market stability and grain stocks has been rekindled. There were two main reasons for the renewed interest. First was the sharp drop in world grain stocks. World wheat and coarse grain stocks dropped to 18 percent of world use in 1990--near the record low of 16 percent in 1974. Second was the discussion of actual and potential policy changes that could change stockholding behavior of governments and individuals around the world. Examples of the latter were the new farm legislation in the U.S. and the GATT negotiations.

In this report we examine how well grain stocks have performed since the late 1970s in adding stability to world grain markets.[2] First we examine the world-aggregate grain data and find that stocks adjustments have been doing a better job of enhancing world market stability since the late 1970s than they did earlier. Then we examine country data to see who may have provided that added stability.

---

[1]Sections of this paper were presented at the International Agricultural Trade Research Consortium, 1990 Annual Meeting, San Diego, California, December 16-18, 1990.

[2] In this report "grain" refers to wheat plus coarse grains.

THE GLOBAL PICTURE

Evidence since the late 1970s suggest that the world's grain stocks are doing a better job of protecting consumers from the year-to-year volatility of the world's grain production (table 1). One measure of stock performance is to compare the volatility of global grain consumption with the volatility of global grain production. If the former is less than the latter, then that is evidence that adjustments of end-of-year grain stocks reduced the impact of production variability on consumers.[3]

The variation of world wheat production around trend, as measured by standard error, was 16.7 million tons (5% of total wheat production) during the period 1960-1977 (table 1). The standard error of consumption in those years was 10.4 million tons (3% of total wheat consumption). Thus the world's wheat stocks helped stabilize grain consumption. From 1978 to 1989 the standard error of wheat production remained at 16.7 million tons (3% of wheat production) but the standard error of global wheat consumption declined to only 6.7 million tons (1% of wheat consumption)--evidence that the world's wheat stocks provided even more protection to consumers than in the earlier years.

In the period 1960-1977, coarse grain stocks were not nearly as effective as wheat stocks in reducing the year-to-year variability of consumption. The standard error of production was 17.9 million tons (3% of coarse grain production) and the standard error of consumption was 14.8 million tons (3% of coarse grain consumption). The reason likely relates to the fact that the major consumers of coarse grains are livestock rather than people. Livestock numbers and feeding rates can be more easily adjusted to the grain supply. Since 1978, the world's coarse grain stocks were extremely effective in offsetting the huge increase in production variability. The standard error of production more than doubled to 44.3 million tons (6% of coarse grain production) but the standard error of consumption dropped to 10.5 million tons (1% of coarse grain consumption).

Another measure of market volatility is the deviation around trend in annual grain prices. The data show a significant reduction in the volatility of wheat and coarse grain prices since 1978, as measured by the coefficient of dispersion (table 1). Theory suggests that reduced price volatility might be caused by improved management of the world's stocks, or by other

---

[3]We use "volatility" and "variability" interchangeably, although "volatility" is associated with more negative connotations.

Table 1. Measures of annual dispersion from trend in world wheat and coarse grain price, production, and consumption over specified years

Item	unit	1960 to 1977	1978 to 1989
Wheat production:			
Standard error[a]	m. tons	16.7	16.7
Coef. of dispersion[b]	percent	5.3	3.4
Wheat consumption:			
Standard error	m. tons	10.4	6.7
Coef. of dispersion	percent	3.3	1.4
Wheat price:[c]			
Standard error	U.S. $/ton	29.4	21.3
Coef. of dispersion	percent	34.0	14.1
Coarse grain production:			
Standard error	m. tons	17.9	44.3
Coef. of dispersion	percent	3.2	5.7
Coarse grain consumption:			
Standard error	m. tons	14.8	10.5
Coef. of dispersion	percent	2.6	1.4
Coarse grain price:[d]			
Standard error	U.S. $/ton	17.5	18.7
Coef. of dispersion	percent	24.5	16.6

[a]Standard error of deviations from trend.

[b]Coefficient of dispersion (CD) is expressed in percentage terms and is calculated by dividing the standard error by the mean and multiplying the result by 100. It is a unitless measure of variation, which removes the effect of production levels on variability.

[c]U.S. Gulf f.o.b. hard red winter (ordinary) wheat price.

[d]U.S. Gulf f.o.b. corn price (no. 2).

forces such as a reduction of trade barriers (Grennes, et. al., 1978).[4] In the sections which follow, we focus on the role of the former.

STOCKS BEHAVIOR: SELECTED COUNTRIES

The rules for managing the world's grain stocks are set by countries. There is no explicit global strategy. In order to understand how the world's stocks are managed, one needs to examine stocks management in the major grain stockholding countries. Guiding our examination of country data are two questions. The first question: To what extent do major grain producing countries manage year-end stocks to offset their own production variability? An associated issue is to what extent do these countries pass domestic production variability onto the world market and make it more volatile. The second question: To what extent do these countries adjust their grain stocks to absorb some of the grain market volatility generated by other countries?

Results show which countries tend to be the major sources of world grain market volatility, and which countries adjust their stocks in a way that adds stability to the world market.

Previous studies have suggested that the Soviet Union is the most important potential "transmitter" of production variability to the grain market while the U.S. (and to a lesser extent Canada and several other countries) has contributed to market stability through stock adjustments. Grain stocks in the European Community (EC) made no noticeable contribution to world grain market stability (Sharples and Goodloe, 1984; Blandford, 1983; Josling, 1980).

A recent report by Sharples and Krutzfeldt (1990) gives an overview of who are the world's current major holders of grain stocks and how those stocks are used. They conclude that, as in the past, the United States still holds most of the world's buffer stocks, i.e., stocks available to the world market to help stabilize it.

The country analysis reported here is a more quantitative follow up to the Sharples-Krutzfeldt report. Using revised methods and more recent data, we examine the major conclusions of reports of the late seventies and early eighties.

---

[4]The term "management" in this paper does not imply that stocks are adjusted with any particular objectives in mind. Adjustments in stocks may simply be an outgrowth of domestic policies.

We proceed by separately examining the wheat and coarse grains stocks behavior in selected countries since stocks behavior differs between the two. We also compare more recent behavior, based on 1978-1989 data, with that observed in earlier years (1960-1977) to see if there is evidence of change in a country's grain stocks management strategies. The two time periods were divided in 1978 because that marked the beginning of several significant events in the world grain markets. In particular:

(1) Import variability in China increased,

(2) Soviet grain production leveled off, and

(3) An upward trend began in EC grain net exports.

By examining differences between the two time periods, insight may be gained into how changes in country policies have affected stock adjustments. Relating observed stockholding behavior to country policies or examining optimal stockholding, however, is a topic for further exploration in another report.[5]

Stocks Adjustments and Domestic Production Variability

A major source of supply instability in a country is domestic grain production. When any major grain producing country has an unusual harvest, it can adjust to that shock any of 3 ways; by adjusting domestic grain consumption, by adjusting the amount of grain stocks carried over to next year, or by adjusting the quantity traded. Their choice of action could have a significant effect on the stability of both the domestic and world grain markets.

For example, suppose that an importing country had an unusually poor wheat harvest one year. They might fully absorb the impact of the poor harvest domestically by cutting back on consumption and/or reducing their carryover stocks. On the other hand, they could completely "export" their production shock into the world market by maintaining trend consumption and trend stock levels, and by increasing wheat imports to offset the poor harvest. Conversely, when the harvest was above normal, they could consume more and also build up ending stocks, or they could simply reduce imports. A strategy of relying on the world market to offset most of their own production variability could add instability to the world market.

---

[5]See Gardner, 1979, for a detailed discussion of the theory behind optimal stock levels and a thorough reference listing for literature in this area.

India, Argentina, and the U.S. illustrate extreme cases of each of the 3 possible responses to domestic coarse grain production shocks. In India, practically all coarse grain production is consumed domestically (figure 1). Coarse grains consumption varies from year to year in response to changes in production. India apparently did not use trade or adjustments in coarse grain stocks to offset production variability.

In Argentina, most production shocks are passed onto the international market (figure 2). Consumption and stock levels are relatively stable. In the United States, coarse grain production has been highly variable since the late 1970s, but consumption has been considerably less variable due to offsetting stock adjustments (figure 3). The magnitude of year-to-year changes in both U.S. production and stocks are huge by world standards in the 1980s. However, the production shocks did not result in large changes in coarse grain exports. U.S. stocks, rather than the world market, absorbed most of the production variability.[6]

These three country examples indicate that they each pursued different coarse grain policy strategies. Argentina's year-to-year changes in production has been a source of world grain market volatility while India and the United States passed on relatively little of their production shocks to the world market. Stocks absorbed production shocks in the U.S. India represents a rare case where consumption rather than stocks absorbed most of their production shocks.

Most major grain producing countries attempt to stabilize grain consumption. If domestic stocks do not adjust to offset production shocks, then it is usually trade that adjusts. Therefore, a country which does not adjust stocks is likely to be transmitting domestic production variability to the world market. In this way the tradeoff between stock and trade adjustments becomes linked to world grain market stability.

Destination of Domestic Production Shocks

For most major grain producing countries, adjustments to production shocks are not as obvious as in the above examples. However, simple regressions can be used to suggest how they have responded to domestic production shocks. The following equations were estimated for each country for each of two time periods,

---

[6] The fact that net exports showed little variability, however, does not mean that U.S. production variability failed to generate instability on the world market. World prices reacted to the large fluctuations in the quantity of coarse grains supplies available for export from the United States.

Figure 1. India Coarse Grains
1960-1989

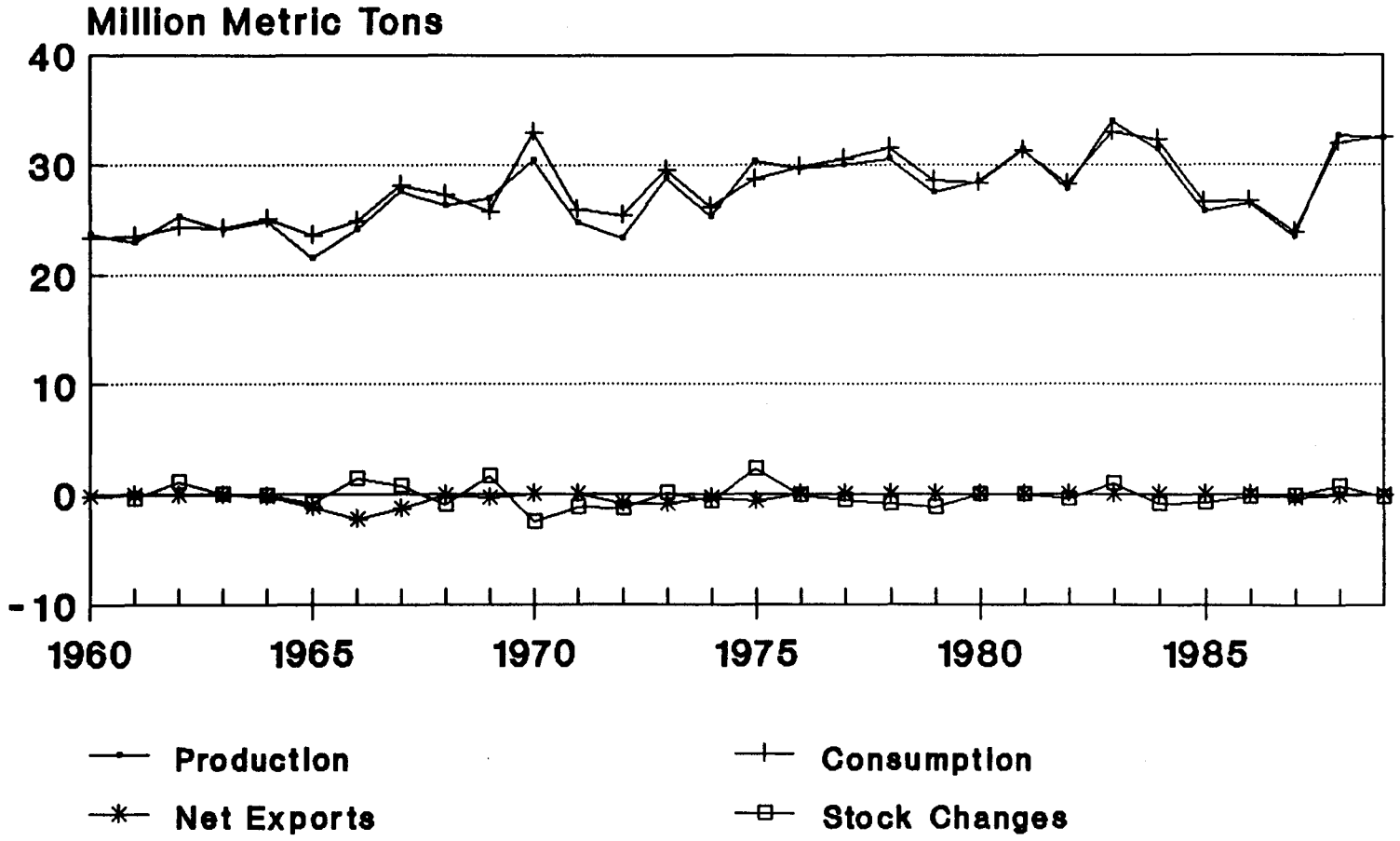


Figure 2. Argentina Coarse Grains
1960-1989

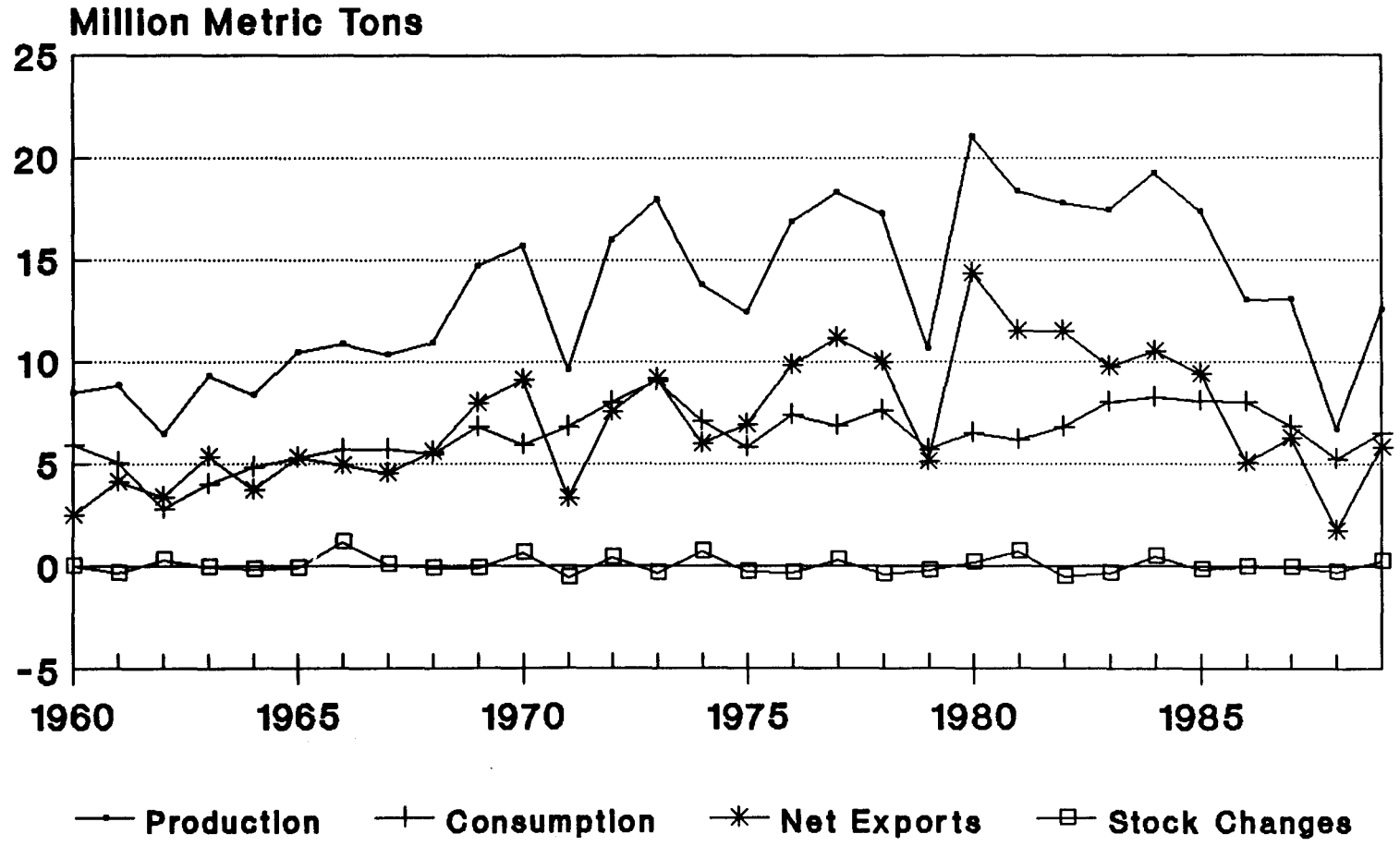
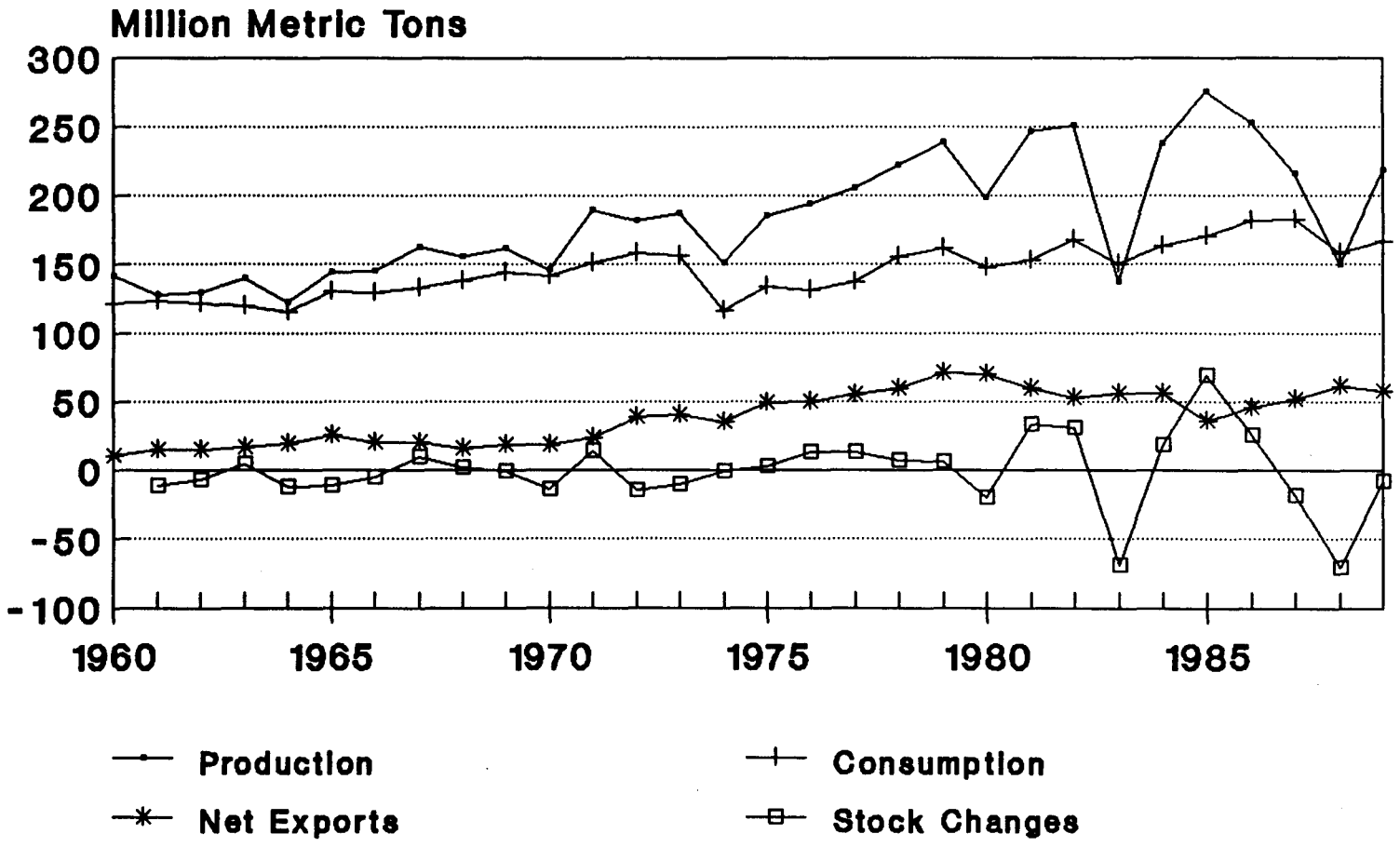


Figure 3. U.S. Coarse Grains
1960-1989



1960 to 1977 and 1978 to 1989:

$$(1)\quad C = (a_1 * Q) + e_1$$

$$(2)\quad T = (a_2 * Q) + e_2$$

$$(3)\quad S = (a_3 * Q) + e_3$$

where Q is the change in production[7] from the previous year, C is the change in domestic use, T is the change in net exports (exports minus imports), and S is the adjustment in stocks.[8] Specifying the equation in this manner forces the equality; $a_1 + a_2 + a_3 = 1.0$, which is convenient for comparison purposes. A larger coefficient suggests greater adjustments in response to production shocks. Estimates of the coefficients in the production shock absorption equations, (1) to (3), are presented in table 2 (wheat) and table 3 (coarse grains).

Wheat Results

The Soviet Union has by far the largest production variability, as measured by standard error (table 2, column 2). The United States is second and China is third. In relative terms, however, Argentina, Australia, and Canada have the most production variability (column 3). Note the low relative production variability since 1977 in Eastern Europe, the EC, China and India.

Results show that major grain producers tend to protect their consumers from domestic production variability, as indicated in table 2 by the low coefficients shown under "Domestic Use." Eastern Europe is a major exception. The lower income countries of India, Mexico, and China also exhibit a

---

[7] Similar equations were estimated for 1960 to 1982 in Sharples and Goodloe (1984). However, they used supply (production plus beginning stocks) rather than production as the independent variable. Use of supply provided ambiguous results for major stockholding countries since volatility of beginning stocks would affect the results.

[8] S measures the difference between the change in stocks in the current period and the change in stocks in the previous period. Specifically:

$$S_t = (E_t - B_t) - (E_{t-1} - B_{t-1})$$

where E is ending stocks and B is beginning stocks.

Table 2. The Allocation of Domestic Wheat Production Shocks For the Major Stockholding Countries/Regions -- 1960/61 to 1977/78 Versus 1978/79 to 1989/90

Country	Production			Proportion of production deviations absorbed by:		
	Average	Standard Error[a]	CD[a]	Domestic Use (a_1)	Trade (a_2)	Stocks (a_3)
	Million metric tons		%	---------Fraction----------		
China*						
1960-77	29.7	3.3	11	.20	.23	.57
1978-89	75.6	6.4	8	.26	.19	.55
Soviet Union*						
1960-77	81.7	13.9	17	.09	.25	.66
1978-89	87.6	12.5	14	.04	.22	.74
United States**						
1960-77	41.6	4.0	10	.04	-.21	1.17
1978-89	62.0	9.4	15	-.06	.35	.71
EC-12**						
1960-77	42.8	3.4	8	.22	.35	.43
1978-89	67.3	5.3	8	.09	.23	.68
India						
1960-77	17.9	2.6	14	.40	.38	.22
1978-89	41.4	2.5	6	.37	.03	.60
Canada**						
1960-77	16.3	4.0	24	.02	.16	.82
1978-89	23.2	4.5	19	.05	.54	.41
Australia**						
1960-77	9.6	2.2	23	.00	.34	.66
1978-89	15.3	3.7	24	-.08	.45	.63
Eastern Europe*						
1960-77	25.3	1.9	7	.51	.27	.22
1978-89	37.2	3.0	8	.66	.28	.06
Turkey**						
1960-77	8.8	1.2	14	.19	.22	.59
1978-89	13.3	0.9	7	-.13	.86	.27

Table 2. Continued

Country	Production: Average	Production: Standard Error	CD[a]	Proportion of production deviations absorbed by: Domestic Use (a_1)	Trade (a_2)	Stocks (a_3)
	Million metric tons		%	---------Fraction----------		
Argentina**						
1960-77	6.8	2.0	29	.22	.73	.05
1978-89	9.8	2.5	25	.05	.98	-.03
Mexico*						
1960-77	2.0	.3	15	.15	.60	.25
1978-89	3.5	.6	17	.24	.51	.25
South Africa						
1960-77	1.3	.2	15	.09	.67	.24
1978-89	2.2	.5	23	.01	.61	.38
World						
1960-77	312.8	16.7	5	.19	---	.81
1978-89	484.3	16.7	3	.28	---	.72

[a]See definitions in table 1.

*Major importer in 1985-89

**Major exporter in 1985-89

Table 3. The Allocation of Domestic Coarse Grain Production Shocks For the Major Stockholding Countries/Regions -- 1960/61 to 1977/78 Versus 1978/79 to 1989/90

Country	Production			Proportion of Production deviations absorbed by:		
	Average	Standard Error[a]	CD[a]	Domestic Use (a_1)	Trade (a_2)	Stocks (a_3)
	Million metric tons		%	---------Fraction----------		
United States**						
1960-77	159.5	13.3	8	.47	.16	.37
1978-89	220.5	42.7	19	.18	-.04	.86
Rest of World[b]						
1960-77	400.4	13.6	3	.74	.05	.21
1978-89	553.5	12.8	2	.66	-.05	.39
China**						
1960-77	54.2	4.0	7	.63	.02	.35
1978-89	87.2	4.5	5	.34	.01	.65
Soviet Union*						
1960-77	72.3	11.4	16	.61	.22	.17
1978-89	95.2	11.3	12	.33	.56	.11
EC-12**						
1960-77	61.0	4.3	7	.33	.56	.11
1978-89	82.3	4.7	6	.17	.27	.56
Eastern Europe*						
1960-77	48.9	2.6	5	.79	.08	.13
1978-89	65.9	4.2	6	.37	.29	.34
India						
1960-77	26.1	2.1	8	.87	.00	.13
1978-89	29.4	3.1	10	.87	.01	.12
Canada**						
1960-77	17.0	2.2	13	.35	.19	.46
1978-89	22.9	2.7	12	.04	.29	.67
Argentina**						
1960-77	12.2	2.0	16	.22	.73	.05
1978-89	15.1	3.8	25	.16	.83	.01

Table 3. Continued

Country	Production: Average	Production: Standard Error	CD[a]	Proportion of Production deviations absorbed by: Domestic Use (a_1)	Trade (a_2)	Stocks (a_3)
	Million metric tons		%	---------Fraction----------		
Mexico**						
1960-77	9.9	.9	9	.43	.46	.11
1978-89	14.0	1.7	12	.22	.79	-.01
South Africa**						
1960-77	7.6	1.9	25	.05	.45	.50
1978-89	9.2	3.2	35	.03	.58	.39
Australia**						
1960-77	3.8	.8	21	.22	.52	.26
1978-89	6.9	1.4	20	.03	.81	.16
Turkey						
1960-77	6.2	.6	10	.68	.02	.30
1978-89	8.4	.7	8	.15	.42	.43
World						
1960-77	559.9	17.9	3	.70	---	.30
1978-89	774.0	44.3	6	.18	---	.82

[a]See definitions in table 1.

[b]World excluding United States.

*Major importer in 1985-89

**Major exporter in 1985-89

tendency of having their consumers absorb a higher proportion of domestic production variability.

The countries that in recent years have used trade to absorb much of their production variability are Argentina, Turkey, South Africa, Mexico, Canada, and Australia (see the coefficients in the "Trade" column). At the other extreme, trade has not been used by India in recent years to offset the variability of domestic wheat production.

Most of the major wheat producing countries use end-of-year stock adjustments to offset at least part of their domestic production variability (see the coefficients in the "Stocks" column). For example, the Soviet Union, which has to contend with highly variable production, does apparently use wheat stocks to offset a large portion of that variability.[9] Wheat stocks in Eastern Europe and Argentina, however, absorbed very little of their production variability in recent years.

Some significant changes have occurred since 1977 in how countries respond to their own wheat production variability. Stocks have become more important in offsetting production variability in the EC and in India, and less important in the U.S. and Canada.

Coarse Grain Results

The United States dominates the coarse grain story as presented in table 3. More than twice as much coarse grains are produced in the U.S. than in any other country, and over recent years the biggest shocks to global production have come from the United States. Note that the standard error of coarse grain production for the United States was 42.7 million tons since 1978/79 whereas it was only 12.8 million tons for the rest of the world.

During the 1960-1977 period, the U.S. let domestic use absorb about half of the production variability with much of the remainder absorbed by stock adjustments. Since then, however, stocks have played a very important role in absorbing the extreme production variability. Over the last 30 years, the United States has not tended to "export" its production shocks by adjusting the quantity exported.

After the United States, the Soviet Union has the second largest standard error of production (table 3). Results show

---

[9] One must discount conclusions that are drawn from grain stock numbers for the Soviet Union and China. Their stock numbers are subject to substantial error.

that in the most recent period domestic use absorbed much less of their production variability. They turned to the export market, and not to stocks, to provide more stability to consumption.

The EC and Eastern Europe exhibited low absolute and relative levels of coarse grain production variability since 1960. Their stocks coefficients in table 3 indicate that they both increased their use of stocks to absorb domestic production shocks since 1978/79.

A Note on Global Aggregate Stock Adjustments

At the global level there are only two ways for the world as a whole to respond to year-to-year changes in grain production; by adjusting consumption or carryover stocks. Results since the late seventies show that the world's wheat consumers absorbed about 28% percent of year-to-year production variability, and ending stocks absorbed the rest (table 2). Thus, stocks provided substantial, but far from complete, protection to the world's wheat consumers from production shocks.

An analysis of world totals for coarse grains after 1977 show that (1) there was a substantial increase in the variability of production, and (2) stock adjustments became much more important in absorbing production shocks. These global results for coarse grains were mainly caused by what was happening in the United States.

Though different analytical methods were used, these world-total conclusions, drawn from tables 2 and 3, are consistent with results in table 1 for the latter time period. The world results for wheat in table 2, however, suggest that consumers absorbed more of the world's wheat production variability after 1977, which appears to contradict findings in table 1.

Quantifying Transmission of Production Shocks

An estimate of the magnitude of a country's production variability that is transmitted to the world market is obtained by multiplying the domestic production standard error by the fraction absorbed by domestic trade (table 4). The result suggests the potential that a country has for transmitting domestic instability to the world. This potential can be high if domestic production variability is high and/or relatively large adjustments in trade occur in response to changes in domestic production.

Major sources of shocks to the world grain market were the Soviet Union, Argentina (exporter), the United States (exporter), Canada (exporter), and Australia (exporter). Consistent with

Table 4. "Standardized" annual domestic production shocks transferred to the world grain market, 1960-1977 and 1978-1989[1]

Country	Wheat		Coarse grain		Total	
	1960-77	1978-89	1960-77	1978-89	1960-77	1978-89
			million tons			
Soviet Union	3.5	2.7	2.5	6.3	6.0	9.0
Argentina	1.5	2.4	1.5	3.1	3.0	5.5
United States	0.8	3.3	2.1	1.7	2.9	5.0
Canada	0.6	2.4	0.4	0.8	1.0	3.2
Australia	0.7	1.7	0.4	1.1	1.1	2.8
European Community-12[2]	1.2	1.2	2.4	1.3	3.6	2.5
South Africa	0.1	0.3	0.8	1.9	1.0	2.2
Eastern Europe[2]	0.5	0.8	0.2	1.2	0.7	2.0
Mexico	0.2	0.3	0.4	1.3	0.6	1.6
China	0.8	1.2	0.1	0.0	0.9	1.2
Turkey	0.3	0.8	0.0	0.3	0.3	1.1
India	1.0	0.1	0.0	0.0	1.0	0.1
Total	11.2	17.2	10.8	19.0	22.0	36.2

[1]Values in this table are obtained from the equation:

$S = F * E$ where:

S (million tons) is the portion of the average annual change in domestic production that is transferred to the world market.

F is the fraction of the annual change in domestic production that is absorbed by changes in net trade volume (a_2 in tables 2 and 3), and E is the standard error of production from trend (from tables 2 and 3).

[2]The region is treated as one country.

earlier studies, results show that the Soviet Union (a major grain importer) transferred the most domestic production variability onto the world wheat market (table 4). The standard error of wheat production in the Soviet Union is relatively large compared to some of the other major producing countries. For this reason, the potential for transmitting instability is high even though stocks absorb most of the production shocks.

Although wheat production variability in Argentina is not as high as some of the other top producing countries, the potential for transmitting instability is still quite high. This is largely due to the substantial portion of production variation which is absorbed by trade adjustments.

In the U.S., coarse grain production variability has increased dramatically in the latter period. Although a small percentage of this variability is exported to the world coarse grain market, extremely variable production makes the U.S. an important source of potential market instability. In the wheat market, the U.S. has moved ahead of the Soviet Union and Argentina in recent years to become the greatest potential contributor to global instability. This can be explained by the doubling of production variability and the larger percentage of this variability that is passed on to the world.

Despite their large volume of grain production, the EC and Eastern Europe exported relatively little of their own production shocks. The main reason is that they had relatively small year-to-year deviations from trend in production.

Earlier, we observed that the global evidence showed that stocks did a better job of providing stable levels of grain to the world's consumers after 1978. One possible explanation was that the major grain producing countries might have used their carryover stocks to absorb more of their own production variability than in previous years. If true, less of that variability would be absorbed by fluctuations in their grain trade. The data in table 4, however, show that this is not the case. Among major grain producing countries, more production variability was transferred to the world market since 1978 than before.

A second possible explanation was that since 1978 more of the world's grain stocks responded to external shocks to the world market, that is, shocks that originated outside the country. This possibility is examined in the next section.

Relationship Between Domestic Stocks and World Price

Countries may be unwilling to make domestic grain stock adjustments (or other domestic market adjustments) in response to

the external volatility of the international grain market. They can accomplish this by putting policies in place that isolate their domestic grain market from the effects of world grain shortages or surpluses. Domestic stocks in countries following this strategy are perceived as being unresponsive to world prices. Their stocks tend to provide no stability to the world market.

On the other hand, countries can manage stocks so that they are responsive to world grain prices, by accumulating stocks when the world price falls, and by drawing them down when the world price rises. Their stocks response would tend to dampen world price fluctuations. Thus a negative relationship between a country's grain stock levels and international price suggests that their stocks have a stabilizing impact on the world market.

Stocks Regression Equation

We used the following equation to measure this relation between stocks and world price after eliminating the effect of trend:

$$S^* = a + bP^* + e, \quad S^* = S - \mathcal{S}, \quad P^* = P - \mathcal{P}$$

where S is ending stocks, $\mathcal{S}$ is trend ending stocks, P is the annual average wheat or corn (used for coarse grain) price at U.S. Gulf ports, and $\mathcal{P}$ is trend price. Deviations from trend (i.e., S^*, P^*) in the regression equation removes the effect of trend in the analysis. A statistically significant negative coefficient on price suggests that a country's stocks tend to have a stabilizing effect on the world market price.

Stocks and World Price Stability Results

Three major points are drawn from the results shown in tables 5 and 6. First, stocks of wheat and coarse grains appear to be much more of a stabilizing force on world markets after 1977 than before. The simple regression for the world total wheat stocks shows that stocks decreased .93 million tons for each U.S. dollar increase in the per ton wheat price. For the period 1960-1977, the relationship was not as strong between world wheat stock levels and world price. Price responsiveness of world coarse grain stocks was also much higher after 1977.

Second, the United States was the major source of the world's price-responsive stocks since 1977. The U.S. stocks coefficient for wheat was nearly half the size of the world total (-.392 compared with a world total of -.934). The U.S. coarse grains stocks coefficient accounted for most of the world total.

Table 5. Relationship Between Wheat Stocks and World Wheat Price By Leading Stockholding Countries

Country	Average Stocks		Price Coefficient[1] (b)	
	1960-77	1978-89	1960-77	1978-89
	Million tons			
United States	24.1	33.0	-.078	-.392*
Rest of World[2]	63.7	104.5	-.138	-.542*
China	9.9	30.0	.034	-.057
Soviet Union	11.9	16.7	-.024	-.132**
EC-12	8.6	12.8	.025*	-.083*
India	4.5	9.6	-.032***	-.134*
Canada	14.5	9.2	-.120*	-.079*
Australia	2.2	4.3	-.025***	-.027
Turkey	1.8	4.2	-.012***	-.015**
Eastern Europe	1.4	1.8	-.003	.001
Argentina	.9	.6	.002	-.002
South Africa	.4	.6	-.001***	.000
Mexico	.2	.4	.001***	-.000
World	87.8	139.7	-.216***	-.934*

*Significant at the 5% level of significance.
**Significant at the 10% level of significance.
***Significant at the 20% level of significance.

[1]$S = a_0 + a_1P$ where S is annual detrended stocks and P is annual detrended U.S. Gulf f.o.b. hard red winter (ordinary) wheat price in U.S. dollars per ton.

[2]World excluding United States.

Table 6. Relationship Between Coarse Grain Stocks and World Coarse Grain Price By Leading Stockholding Countries

Country	Average Stocks		Price Coefficient[1] (b)	
	1960-77	1978-89	1960-77	1978-89
	Million tons			
United States	44.3	81.4	-.190	-1.641*
Rest of World[2]	52.6	78.3	.090***	-.086
China	15.2	27.7	.112*	.099**
EC-12	7.3	10.9	.036*	-.076*
Soviet Union	6.4	7.1	.016	-.047***
Canada	5.5	5.7	-.020***	-.034***
Eastern Europe	1.9	4.7	-.009***	-.031*
Mexico	.8	1.5	.008***	.036**
South Africa	1.3	1.4	.001	.015
India	4.7	1.3	-.044*	.014**
Turkey	.4	.9	-.009*	-.002
Argentina	.5	.6	.006**	-.002
Australia	.6	.5	-.015*	-.001
World	96.9	159.7	-.100	-1.727*

*Significant at the 5% level of significance.
**Significant at the 10% level of significance.
***Significant at the 20% level of significance.

[1]$S = a_0 + a_1P$ where S is annual detrended stocks and P is annual detrended U.S. Gulf f.o.b. corn price (no. 2) in U.S. dollars per ton.

[2]World excluding United States.

The U.S. results for 1978-1989 are consistent with results from other studies cited above; that is, the United States tends to hold a very large share of the world's buffer stocks of grain. As explained in Sharples and Goodloe (1984) and Sharples and Krutzfeldt (1990), U.S. stock levels tend to be driven by domestic grain policy objectives, and not by world price stabilization objectives. Grain stockpiles tend to be viewed by the domestic agricultural community as undesirable.

Third, after being a destabilizing force in the world grain markets prior to 1977, EC grain stocks thereafter became a significant stabilizing force. During 1960-1977, EC wheat and coarse grain stocks showed a significant positive relationship with world price--a destabilizing force on the world wheat market. Since 1977, grain stocks in the EC exhibit a significant negative relationship with price. Though the estimated coefficients are small, this appears to be a significant change in behavior.

The EC stocks response of recent years is a new stabilizing force on the world grain market. The significant negative (stabilizing) relationship between EC stock levels and world price for 1978-1989 is especially interesting since the EC grain markets are completely insulated from world prices. The change in EC stock management patterns appears to be related to the EC becoming a large grain exporter. In the sixties and seventies the EC was a net importer. It turned to the world market in response to supply needs, especially for coarse grains, as indicated by the trade coefficients (table 2 and table 3). As EC exports rapidly expanded in the late seventies and eighties, government export subsidies were provided to make up the difference between high internal support prices and the world price. Apparently, when world prices fell, some grain tended to be stored rather than exported in order for the government to hold down the high export subsidy payments. At higher world prices, stocks could be drawn down and exported with lower export subsidies. Hence the stabilizing effect on world prices of EC stock adjustments likely has been caused by domestic budget considerations.

India and Canada also had wheat stocks that in recent years responded in a stabilizing way to world price. The size of Canada's stocks response, however, was relatively small. Coarse grain stocks in Eastern Europe also showed a small stabilizing response to world price.

CONCLUSIONS AND POLICY IMPLICATIONS

World grain markets appear in recent years--since 1977--to be doing a better job than earlier in allocating the world's

grain from one year to the next. Evidence of this is (a) less year-to-year variability around trend in global grain consumption, even though world production variability has increased, and (b) less world grain price volatility than prior to 1978, despite transmission of more production variability onto the world market by major producing countries. The world's grain stocks apparently are providing more market stability than they did prior to 1978.

This study examines the role of each of the major grain producing countries--who are also the major holders of grain stocks--in generating instability or providing stability to world grain markets by how they manage their own stocks. The rules determining how grain stocks are managed vary among countries. In this study we do not examine those rules. Rather, we examine actual stock adjustments. The forces determining a country's stock management behavior should be the subject of further research.

A country's grain stocks can contribute to world market stability two ways:

(1) Stocks may be used to offset a country's own production variability so that it would not need to vary its grain trade (imports or exports) in order to achieve stability of consumption.

(2) Stocks may be used to offset surpluses or shortages on the world market.

We discovered no overall improvement since 1977 in the use of grain stocks to offset domestic production variability. Thus we conclude that (1) was not a source of added stability to the world grain markets. We did, however, find substantial improvement in the responsiveness of grain stocks in several important countries, to world market conditions (Table 7). The second item listed above appears to be a significant source of reduced instability in world grain markets since 1977, especially for wheat. Not only did the unitless measure of dispersion of wheat prices fall in the latter period, but so too did the standard error (table 1).

Conclusions suggesting that the U.S. has borne the cost of holding stocks which help to stabilize the world market appears to be supported more in the wheat market compared to coarse grains. Excluding the U.S. from the coarse grains market, the rest of the world has failed to adjust stocks to help stabilize the market in recent years. It does appear, however, that only a few countries are responsible for stabilizing effects in either of the grain markets.

Production variability in the Soviet Union, Argentina, and

Table 7. Summary of Absorption Effect in Selected Countries for Wheat and Coarse Grain, 1960-1977 and 1978-1989

	Coarse Grains		Wheat	
Country	1960-77	1978-89	1960-77	1978-89
United States	---	Stab.	---	Stab.
Rest of World*	---	---	---	Stab.
China	Destab.	---	---	---
Soviet Union	---	---	---	---
EC-12	Destab.	Stab.	Destab.	Stab.
Canada	---	---	Stab.	Stab.
Eastern Europe	---	Stab.	---	---
India	Stab.	---	---	Stab.
Turkey	Stab.	---	---	---
Argentina	---	---	---	---
Australia	Stab.	---	---	---
South Africa	---	---	---	---
Mexico	---	---	---	---

[a]If the price regression coefficient in the stocks equation is not significant at the 5% level (tables 5 and 6), the country is presented here as having no absorption effect.
*World excluding the U.S.

the United States appear to be major sources of instability to world grain markets in recent years. Although a substantial portion of production variability in the Soviet Union and the United States is absorbed by adjustments in domestic stocks, a significant portion still shows up in adjustments to their trade volume. Argentina appears to pass on most of its production variability to the world grain markets. Argentina makes no world market-stabilizing adjustments in domestic grain stocks.

Most major grain producing countries "exported" more production variability onto the world market after 1977 than before. An exception was the EC.

Results of this study verified the conclusion of previous studies that U.S. stocks provided a major stabilizing force on world grain markets. Results since 1977 also show, however, that the United States was a major source of the world's grain production variability. Massive adjustments in U.S. grain stock levels offset most of that production variability. Further, U.S. stocks were very responsive, in a stabilizing way, to world grain price movements.

Stock adjustments made in the EC in recent years appear to contribute significantly to world grain market stability. This is a surprising conclusion. Our results indicate that in earlier years EC stocks were a destabilizing force on world markets.

Recent policy changes by the United States could lead to the U.S. playing a reduced role in stabilizing world grain markets. Because of the dominant role of the U.S. in stabilizing world grain markets, these policy changes could be very significant to all countries who participate in the world grain market. The 1990 farm bill allows grain price supports to continue their downward adjustment. With price supports set closer to the low end of world market fluctuations, there would be little incentive for U.S. grain to go into Government stocks. The farm bill also downsizes the farmer-owned reserve. Finally, continued or expanded funding for the Export Enhancement Program (EEP) also would tend to destabilize world grain markets. The EEP likely would be used more aggressively to encourage U.S. grain exports (and reduce stocks) when grain prices were low, and used less aggressively when grain prices were high.

Results of this study also bring up questions about the impact of trade liberalization on the stability of world grain markets. Conventional economic wisdom is that reduced trade barriers would increase grain market stability. This would occur by exposing a larger portion of the world's production, consumption and stockholding to world prices. Results from this study also show, however, that the domestic policies of the U.S. and the EC induce market-stabilizing stocks behavior--although the impact of U.S. policies could be diminishing, as discussed

above. Liberalizing trade could remove those policy-induced sources of market stabilization. Although some would argue that policy-induced stabilization is less desirable because it is subject to political whims, the net effect of trade liberalization on world grain market stability appears less clear. This question warrants further research.

Selected References

Blandford, D. "Instability in World Grain Markets," Jour. Agr. Econ. 34(1983):379-95.

Gardner, B.L. Optimal Stockpiling of Grain. Lexington, Massachusetts: Lexington Books, 1979.

Grennes, T., P.R. Johnson, and M. Thursby. "Insulating Trade Policies, Inventories, and Wheat Price Stability," Amer. Jour. of Agricultural Economics. 60(1978):132:134.

Houck, J.P. and M.E. Ryan. Economic Research on International Grain Reserves: The State of Knowledge, Bul. 532, Agr. Exp. Sta., Univ. of Minn., 1979.

Josling, T. Developed-Country Agricultural Policies and Developing-Country Supplies: The Case of Wheat, Res. Rpt. 14, Intl. Food Policy Res. Inst., Mar. 1980.

Sharples, J.A. and C.A. Goodloe. "Global Stocks of Grain: Implications for U.S. Policy," Staff Report No. AGES 840319, U.S. Dept. Agr., Econ. Res. Serv., May 1984.

Sharples, J.A. and J. Krutzfeldt. "World Grain Stocks: Where They Are and How They Are Used" U.S. Dept. Agr., Econ. Res. Serv., AIB-594. Mar. 1990.

INTERNATIONAL AGRICULTURAL TRADE RESEARCH CONSORTIUM*

Working Papers Series

Number	Title	Author(s)	Send correspondence or requests for copies to:
85-1	Do Macroeconomic Variables Affect the Ag Trade Sector? An Elasticities Analysis	McCalla, Alex Pick, Daniel	Dr Alex McCalla Dept of Ag Econ U of California Davis, CA 95616
86-1	Basic Economics of an Export Bonus Scheme	Houck, James	Dr James Houck Dept of Ag Econ U of Minnesota St Paul, MN 55108
86-2	Risk Aversion in a Dynamic Trading Game	Karp, Larry	Dr Larry Karp Dept of Ag & Resource Econ/U of California Berkeley, CA 94720
86-3	An Econometric Model of the European Economic Community's Wheat Sector	de Gorter, Harry Meilke, Karl	Dr Karl Meilke Dept of Ag Econ U of Guelph Guelph, Ontario CANADA N1J 1S1
86-4	Targeted Ag Export Subsidies and Social Welfare	Abbott, Philip Paarlberg, Philip Sharples, Jerry	Dr Philip Abbott Dept of Ag Econ Purdue University W Lafayette, IN 47907
86-5	Optimum Tariffs in a Distorted Economy: An Application to U.S. Agriculture	Karp, Larry Beghin, John	Dr Larry Karp Dept of Ag & Resource Econ/U of California Berkeley, CA 94720
87-1	Estimating Gains from Less Distorted Ag Trade	Sharples, Jerry	Dr Jerry Sharples USDA/ERS/IED/ETP 628f NYAVEBG 1301 New York Ave NW Washington, DC 20005-4788
87-2	Comparative Advantage, Competitive Advantage, and U.S. Agricultural Trade	White, Kelley	Dr Kelley White USDA/ERS/IED 732 NYAVEBG 1301 New York Ave NW Washington, DC 20005-4788

Number	Title	Author(s)	Send correspondence or requests for copies to:
87-3	International Negotiations on Farm Support Levels: The Role of PSEs	Tangermann, Stefan Josling, Tim Pearson, Scott	Dr Tim Josling Food Research Institute Stanford University Stanford, CA 94305
87-4	The Effect of Protection and Exchange Rate Policies on Agricultural Trade: Implications for Argentina, Brazil, and Mexico	Krissoff, Barry Ballenger, Nicole	Dr Barry Krissoff USDA/ERS/ATAD 624 NYAVEBG 1301 New York Ave NW Washington, DC 20005-4788
87-5	Deficits and Agriculture: An Alternative Parable	Just, Richard Chambers, Robert	Dr Robert Chambers Dept of Ag & Resource Economics Univ of Maryland College Park, MD 20742
87-6	An Analysis of Canadian Demand for Imported Tomatoes: One Market or Many?	Darko-Mensah, Kwame Prentice, Barry	Dr Barry Prentice Dept of Ag Econ & Farm Mgmt University of Manitoba Winnipeg, Manitoba CANADA R3T 2N2
87-7	Japanese Beef Policy and GATT Negotiations: An Analysis of Reducing Assistance to Beef Producers	Wahl, Thomas Hayes, Dermot Williams, Gary	Dr Dermot Hayes Dept of Economics Meat Export Research Center Iowa State University Ames, IA 50011
87-8	Grain Markets and the United States: Trade Wars, Export Subsidies, and Price Rivalry	Houck, James	Dr James Houck Dept of Ag Econ Univ of Minnesota St Paul, MN 55108
87-9	Agricultural Trade Liberalization in a Multi-Sector World Model	Krissoff, Barry Ballenger, Nicole	Dr Barry Krissoff USDA/ERS/ATAD 624 NYAVEBG 1301 New York Ave NW Washington, DC 20005-4788
88-1	Developing Country Agriculture in the Uruguay Round: What the North Might Miss	Mabbs-Zeno, Carl Ballenger, Nicole	Dr Nicole Ballenger USDA/ERS/ATAD 624 NYAVEBG 1301 New York Ave NW Washington, DC 20005-4788

Number	Title	Author(s)	Send correspondence or requests for copies to:
88-2	Two-Stage Agricultural Import Demand Models Theory and Applications	Carter, Colin Green, Richard Pick, Daniel	Dr Colin Carter Dept of Ag Economics Univ of California Davis, CA 95616
88-3	Determinants of U.S. Wheat Producer Support Price: A Time Series Analysis	von Witzke, Harald	Dr Harald von Witzke Dept of Ag Economics Univ of Minnesota St Paul, MN 55108
88-4	Effect of Sugar Price Policy on U.S. Imports of Processed Sugar-containing Foods	Jabara, Cathy	Dr Cathy Jabara Office of Econ Policy U.S. Treasury Dept 15th & Pennsylvania Ave NW Washington, DC 20220
88-5	Market Effects of In-Kind Subsidies	Houck, James	Dr James Houck Dept of Ag Economics University of Minnesota St Paul, MN 55108
88-6	A Comparison of Tariffs and Quotas in a Strategic Setting	Karp, Larry	Dr Larry Karp Dept of Ag & Resource Econ/U of California Berkeley, CA 94720
88-7	Targeted and Global Export Subsidies and Welfare Impacts	Bohman, Mary Carter, Colin Dortman, Jeffrey	Dr Colin Carter Dept of Ag Economics U of California, Davis Davis, CA 95616
89-1	Who Determines Farm Programs? Agribusiness and the Making of Farm Policy	Alston, Julian Carter, Colin Wholgenant, M.	Dr Colin Carter Dept of Ag Economics U of California, Davis Davis, CA 95616
89-2	Report of ESCOP Subcommittee on Domestic and International Markets and Policy	Abbott, P.C. Johnson, D.G. Johnson, R.S. Meyers, W.H. Rossmiller, G.E. White, T.K. McCalla, A.F.	Dr Alex McCalla Dept of Ag Economics U of California-Davis Davis, CA 95616
89-3	Does Arbitraging Matter? Spatial Trade Models and Discriminatory Trade Policies	Anania, Giovanni McCalla, Alex	Dr Alex McCalla Dept of Ag Economics U of California-Davis Davis, CA 95616

Number	Title	Author(s)	Send correspondence or requests for copies to:
89-4	Export Supply and Import Demand Elasticities in the Japanese Textile Industry: A Production Theory Approach	Pick, Daniel Park, Timothy	Daniel Pick USDA/ERS/ATAD 1301 New York Ave. N.W. Washington, DC 20005-4788
89-5	The Welfare Effects of Imperfect Harmonization of Trade and Industrial Policy	Gatsios, K. Karp, Larry	Dr. Larry Karp Dept. of Ag & Resource Econ/U of California Berkeley, CA 94720
89-6	Report of the Task Force on Tariffication and Rebalancing	Josling, Tim Chair	Dr. Timothy Josling Food Research Institute Stanford University Stanford, CA 94305-6084
89-7	Report of the Task Force on Reinstrumentation of Agricultural Policies	Magiera, Stephen Chair	Stephen L. Magiera USDA/ERS/ATAD 1301 New York Ave., Rm 624 Washington, D.C. 20005-4788
89-8	Report of the Task Force on The Aggregate Measure of Support: Potential Use by GATT for Agriculture	Rossmiller, G.E. Chair	Dr. G. Edward Rossmiller Resources for the Future Nat'l Ctr for Food/Ag Policy 1616 P Street N.W. Washington, D.C. 20036
89-9	Agricultural Policy Adjustments in East Asia: The Korean Rice Economy	Kwon, Yong Dae Yamauchi, Hiroshi	Dr. Hiroshi Yamauchi Dept. of Ag & Res. Econ. University of Hawaii 3050 Maile Way Gilmore Hall Honolulu, Hawaii 96822
90-1	Background Papers for Report of the Task Force on The Aggregate Measure of Support: Potential Use by GATT for Agriculture	Rossmiller, G.E. Chair	Dr. G. Edward Rossmiller Resources for the Future Nat'l Ctr for Food/Ag Policy 1616 P Street N.W. Washington, D.C. 20036
90-2	Optimal Trade Policies for a Developing Country Under Uncertainty	Choi, E. Kwan Lapan, Harvey E.	Dr. E. Kwan Choi Dept. of Economics Iowa State University Ames, Iowa 50011
90-3	Report of the Task Force on The Comprehensive Proposals for Negotiations in Agriculture	Josling, Tim Chair	Dr. Timothy Josling Food Research Institute Stanford University Stanford, CA 94305-6084

Number	Title	Author(s)	Send correspondence or requests for copies to:
90-4	Uncertainty, Price Stabilization & Welfare	Choi, E. Ewan Johnson, Stanley	Dr. E. Kwan Choi Dept. of Economics Iowa State University Ames, IA 50011
90-5	Politically Acceptable Trade Compromises Between The EC and The US: A Game Theory Approach	Johnson, Martin Mahe, Louis Roe, Terry	Dr. Terry Roe Dept. of Ag & Applied Econ 1994 Buford Avenue University of Minnesota St. Paul, MN 55108
90-6	Agricultural Policies and the GATT: Reconciling Protection, Support and Distortion	de Gorter, Harry Harvey, David R.	Dr. Harry de Gorter Dept. of Ag Economics Cornell University Ithaca, NY 14853
91-1	Report of the Task Force on Reviving the GATT Negotiations in Agriculture	Trade Update Notes	Dr. Maury E. Bredahl Center for International Trade Expansion 200 Mumford Hall Missouri University Columbia, MO 65211
91-2	Economic Impacts of the U.S. Honey Support Program on the Canadian Honey Trade and Producer Prices	Prentice, Barry Darko, Kwame	Dr. Barry E. Prentice University of Manitoba Dept of Ag Economics & Farm Management Winnipeg, Manitoba R3T 2N2 CANADA
91-3	U.S. Export Subsidies in Wheat: Strategic Trade Policy or an Expensive Beggar-My-Neighbor Tatic?	Anania, Giovanni Bohman, Mary Colin, Carter A.	Dr. Colin Carter Dept of Ag Economics Univ. California-Davis Davis, CA 95616
91-4	The Impact of Real Exchange Rate Misalignment and Instability on Macroeconomic Performance in Sub-Saharan Africa	Ghura, Dhaneshwar Grennes, Thomas J.	Dr. Thomas J. Grennes Dept of Economics & Business North Carolina State Univ P.O. Box 8109 Raleigh, NC 27695-8109
91-5	Global Grain Stocks and World Market Stability Revisited	Martinez, Steve Sharples, Jerry	Steve Martinez USDA/ERS/ATAD 1301 New York Ave NW Room 624 Washington, DC 20005-4788

*The International Agricultural Trade Research Consortium is an informal association of university and government economists interested in agricultural trade. Its purpose is to foster interaction, improve research capacity and to focus on relevant trade policy issues. It is financed by the USDA, ERS and FAS, Agriculture Canada and the participating institutions.

The IATRC Working Paper Series provides members an opportunity to circulate their work at the advanced draft stage through limited distribution within the research and analysis community. The IATRC takes no political positions or responsibility for the accuracy of the data or validity of the conclusions presented by working paper authors. Further, policy recommendations and opinions expressed by the authors do not necessarily reflect those of the IATRC.

Correspondence or requests for copies of working papers should be addressed to the authors at the addresses listed above.

A current list of IATRC publications is available from:

Laura Bipes, Administrative Director
Department of Agricultural & Applied Economics
University of Minnesota
231g Classroom Office Building
1994 Buford Ave
St. Paul, MN 55108
U.S.A.