UNIVERSITY OF CALIFORNIA DIVISION OF AGRICULTURAL SCIENCES
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS

The World Wheat Economy: An Empirical Analysis

Andrew Schmitz and D. Lee Bawden

Giannini Foundation Monograph Number 32 • March 1973

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The major purpose of this study is to calculate the long-run price and trade effects for the world wheat industry from major changes in both technology and governmental policy. Both a theoretical and an empirical model are constructed for the world wheat industry. The data used are wheat demand and supply relationships for consuming and producing regions and wheat shipping costs. For analytical purposes the world wheat economy is divided into 15 regions.

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Andrew Schmitz and D. Lee Bawden

THE WORLD WHEAT ECONOMY: AN EMPIRICAL ANALYSIS[1]

INTRODUCTION

The Problem

PRIOR TO WORLD WAR II, the world wheat economy experienced increasing world surpluses, declining trade, and falling world prices—a situation which began to develop in the late 1920's and climaxed during the depression of the 1930's (de Hevesy, 1940). Later, looking ahead to the post-World War II era, Malenbaum (1953, p. 217) asked:

> "Will the tendency to overproduce persist? If so, what measures will prevent inordinate hardships for producers? Will stocks tend to accumulate? If such is indeed the prospect, what disposal procedures are apt to be adopted? Finally, are there desirable goals and objectives for wheat production and utilization in the world? If there are, is the wheat economy adaptable to achieve them?"

Since World War II, significant developments have taken place in the world wheat economy:

1. During 1953–54 the United States Congress enacted P. L. 480 in order to provide for the distribution of U. S. wheat on a concessional or noncash basis.
2. The world's two largest wheat exporters, the United States and Canada, experienced their largest accumulation of wheat stocks in history.
3. Canada sold sizable quantities of wheat to Communist China and the U.S.S.R.
4. The European Economic Community (EEC) was formed, and because of increased price supports, caused cereal production to increase substantially.
5. In the late 1960's a new International Cereals Agreement was negotiated which was to replace the previous International Wheat Agreement; however, wheat has been sold for prices below the minimum agreed upon.
6. The "Green Revolution"—a term which refers to the rapid adoption by Asian farmers of improved varieties of rice and wheat—occurred.
7. For the first time in history, Canadian wheat farmers were paid to take land out of wheat production.
8. In 1972 the U.S.S.R. imported large quantities of wheat from the U. S.

Some Relevant Questions

As a result of these developments, questions, including the following, have been raised: Will the U.S.S.R. and Communist China enter the market and buy sizable quantities of wheat as they did in the early 1960's? What will be the long-run production, trade, and price impact of the EEC's common agricultural policy? Will production have to be restricted severely in order for wheat prices to be in the range negotiated in the Cereals Agreement? Will there be a large buildup of world wheat stocks unless production is restricted or wheat shipments under food aid programs are expanded? What will be the likely effects of the Green Revolution on wheat export prices? What effect would increased trade with Communist countries have on producers' prices and supply? What will be the effects on prices,

[1] Submitted for publication July, 1972.

production, and trade of such government polices as the abandonment of acreage controls, establishment of quotas, increased tariff protection, and smaller export subsidies? In view of the 1967 Cereals Agreement, will the prices negotiated allow a country like the United States to pursue a policy of gradual abandonment of acreage controls and, at the same time, prevent an accumulation of burdensome surpluses?

The Method of Analysis

This study uses spatial price-international trade models to answer these and other questions specific to the world wheat economy. Its main emphasis is on prediction—prediction of wheat prices, production, consumption, and trade flows to 1980. It does not provide answers to the type of questions asked by Malenbaum concerning the desirability of goals and objectives for wheat production. Whether Canada and the U. S. should trade with the U.S.S.R., whether a free-trade policy is better than tariff protection, and whether there should be international wheat agreements are questions of great interest, but they are not dealt with here; nor is an attempt made to quantify the income and balance-of-payments effects resulting from international trade in wheat.

To quantitatively predict (within the spatial price equilibrium trade framework) the effect on wheat prices and other related phenomena from a change in government policy or from a change in several policies involving a group of trading nations, empirical estimates are made of wheat supply and demand relationships for major wheat producing and trading nations and of the costs involved in transferring wheat from producers to final consumers. These data are then projected to 1980 and incorporated into the spatial price equilibrium framework. From the spatial price model, prices, production, consumption, and trade flows are predicted, given specific governmental wheat policies in each region. The analysis is then carried out under different sets of assumptions about policies, such as acreage controls and price supports which directly affect the world wheat economy.

There are data available for many of the wheat-trading nations from which to estimate statistically wheat demand and supply functions where these are specified to include such variables as wheat prices. But the theory of demand and supply embodies some serious limitations for empirical application. There is always the problem of model misspecification (improper choice of variables, equation form, estimating procedure, etc.), and inaccurate or unavilable data also introduce unavoidable bias in the estimated parameters. There is then the further problem of extrapolating to 1980. The errors can be substantial if the estimated coefficients derived from past time series data are biased or if, over the forecasting period, the supply and demand structure drastically changes. If the structure has not changed, it is unlikely that, within some reasonable range, the length of the time series from which the equations are estimated is critical. For example, per capita demand for wheat in Canada has been very stable over time; thus, whether one uses time series data from 1950–1965 to project demand to 1980 or data from 1950–1968 should not greatly affect the results. But even if the structure has not changed greatly over the period used for estimation, there is no guarantee that it will not change over the forecasting period.

Unfortunately, only scant data are available concerning the factors influencing wheat production and consumption for nations such as the Soviet Union, Communist China, and for various Asian countries where the Green Revolution has occurred. These nations historically have been large wheat producers and recently have become large wheat importers. However, the picture could change substantially by 1980 as a result of the introduction of new varieties and improved cultural practices. Because of data limitations and our hypothesis that the interplay of supply and demand is largely insignificant in determining supply and demand patterns in many of these countries, it is possible to make only point estimates and predictions to 1980. Since nations, such as the Soviet Union, are extremely important in determining the future of the world wheat economy, spatial price equilibrium results are derived from alternative point projections ranging from "high" to "low" export-import gaps. Thus, the results show a range of wheat prices, production, consumption, and trade flows which can be expected in the future.

In view of the many problems encountered in obtaining data which can be used in a spatial price equilibrium framework, this study may be viewed by some as "naive empiricism." However, trade policy decisions have to be made, a good many of which depend on the degree of responsiveness of producers and consumers to price changes. One alternative to the quantitative estimation of supply and demand relationships is to guess at them. The other alternative is to derive a qualitative structural model. It is hoped, however, that our efforts are superior to these approaches; still, limitations of quantitative analysis—especially where the attempt is to provide long-run predictions for a specific industry, such as the world wheat economy—should be kept firmly in mind.

WORLD WHEAT PRODUCTION, CONSUMPTION, AND TRADE

A General Overview

As Liebfried (1965, p. 55) has stated:

> "Wheat has long been one of the staple foods for a large part of mankind. No one knows when or where wheat, the so-called Queen of Cereals, was first grown. But, wheat has been found in graves of the Neolithic Age, which dates back seven or eight thousand years. Bread-making methods are believed to have been discovered in ancient Egypt. Old clay tablets of Mesopotamia reveal a lively wheat trade as early as 3000 B.C., as does the Biblical story of Joseph in Egypt about 1700 B.C. The latter story also indicates the early emphasis given to the storage of wheat against times of emergency. So important was wheat in ancient Egypt, Greece, and Rome that taxes were paid in terms of it and laws were passed to regulate its trade."

Today the largest cereal crop in the world is wheat, occupying slightly over one-fifth of the total cultivated acreage. Rice is second in importance, utilizing about 13 percent of the cultivated acreage (Brown, 1963, p. 21). Wheat production and acreage by major regions of the world are presented in table 1. The central plan countries (U.S.S.R., Eastern Europe, and Communist Asia) produce roughly one-third of the world wheat total. The next largest wheat producing regions (United States, Canada, Argentina, Australia, and New Zealand) account for roughly one-quarter of the world's total wheat production of over 200 million metric tons, produced on roughly 500 million acres of land.

Individual country rankings by production and acreage differ for some countries because of differences in wheat yields. The U.S.S.R., however, leads in both categories and produces over one-fourth of the world wheat total. The United States is third in acreage but second in production while Communist China is just the

TABLE 1

TOTAL WHEAT PRODUCTION AND AREA FOR THE MAJOR REGIONS OF THE WORLD ANNUAL AVERAGES, 1963-64 TO 1965-66 AND 1966-67 TO 1968-69

Region	Production		Area	
	1963-64 to 1965-66	1966-67 to 1968-69	1963-64 to 1965-66	1966-67 to 1968-69
	1,000 metric tons		*1,000 hectares*	
Developed countries				
Major exporters				
United States	33,982	40,010	19,537	22,111
Canada	17,899	18,780	11,542	12,041
Argentina	8,759	6,329	5,354	5,621
Australia and New Zealand	8,934	12,044	7,085	9,551
Total	69,574	77,163	43,518	49,324
Major importers				
Japan	1,082	1,011	522	370
EEC	28,112	30,089	10,407	9,985
United Kingdom	3,670	3,615	899	,939
Other Western Europe	10,132	11.203	7,163	6,748
Republic of South Africa	876	976	1,583	1,715
Total	43,872	46,894	20,574	19,757
Central plan countries				
U.S.S.R.	48,066	72,076	67,565	68,071
Eastern Europe	19,183	24,396	9,995	10,334
Communist Asia	23,266	21,600	24,900	24,500
Total	90,515	118,072	102,460	102,905
Less-developed countries				
Central America and Caribbean	1,924	1,850	856*	775*
East South America	697	795	801	923
West South America	1,647	1,548	1,242	1,111
North Africa	4,632	4,585	5,573	5,360
West Africa	25	32	†	
East Africa	488	606		
West Asia	12,301	14,395	11,999	12,222
South Asia	17,496	20,275	21,018	18,026
Southeast Asia	53	71	91‡	137‡
East Asia and Pacific	299	346	157§	167§
Total	39,562	44,503	41,737	38,721
Total World	243,523	286,632	208,289	210,707

*Includes Mexico and Guatemala.
†Blanks indicate no data available.
‡Includes Burma.
§Includes Korea and Taiwan.
Source: U.S. Economic Research Service (1970).

reverse—second in acreage and third in production. Canada and France are the fourth and fifth leading producers, respectively. While there has been considerable shifting among positions from year to year in the lower five rankings, since at least 1949 the top five producers have remained in the order stated above.[2]

International trade in wheat represents a sizable portion of the total world trade in cereals. The value of wheat exports is larger than the total export value of all other cereal crops (Food and Agriculture Organization of the United Nations, 1964). Interestingly, there is considerable disparity between the ranking of regions according to the volume of wheat production and their position as world

[2] With the top 3 producers (U.S.S.R., United States, and Communist China) accounting for nearly half the total world supply and the top 10 for three-fourths of the total, world wheat production is highly concentrated geographically. It is, of course, further concentrated within the individual countries.

TABLE 2
TRADE AND CONSUMPTION OF WHEAT BY MAJOR REGIONS OF THE WORLD
ANNUAL AVERAGES, 1964-65 TO 1966-67 AND 1967-68 TO 1968-69

Region	1964-65 to 1966-67			1967-68 to 1968-69		
	Imports	Exports	Consumption	Imports	Exports	Consumption
	1,000 metric tons					
Developed countries						
Major exporters						
United States	35	21,198	18,637	14	17,446	19,378
Canada	0	13,848	4,159	0	8,801	4,368
Argentina	0	5,063	3,863	74	2,078	4,491
Australia and New Zealand	138	6,477	2,720	74	6,192	2,960
Major Importers						
Japan	3,727	82	4,759	4,106	103	4,994
EEC	4,391	5,679	27,703	4,476	5,104	28,903
United Kingdom	4,343	14	8,166	4,327	14	7,999
Other Western Europe	1,908	568	11,501	1,405	1,553	6,289
Republic of South Africa	367	1	1,136	106	0	1,291
Central plan countries						
U.S.S.R.	4,903	2,495	65,475	841	5,241	80,947
Eastern Europe	6,294	579	26,563	4,064	1,285	23,180
Communist Asia	5,733	11	28,655	4,404	47	32,272
Less-developed countries						
Central America & Caribbean	1,280	304	2,870	1,954	142	3,822
East South America	3,087	77	3,813	3,440	21	4,308
West South America	1,221	0	2,836	1,357	0	2,956
North Africa	3,647	76	7,691	4,332	20	9,546
West Africa	658	31	653	627	9	651
East Africa	322	17	789	313	2	1,337
West Asia	2,048	101	14,422	2,505	159	19,277
South Asia	9,346	3	26,654	8,151	16	29,970
Southeast Asia	187	8	253	145	0	215
East Asia and Pacific	2,141	63	2,410	2,883	17	3,214

Sources: For years 1964-65 to 1966-67: U.S. Economic Research Service (1970); For years 1967-68 to 1968-69: International Wheat Council (1970); For years 1967-68 to 1968-69: Less-developed countries—Food and Agriculture Organization of the United Nations (1970).

wheat exporters and importers (table 2). North and Central America together are the largest exporting regions, though they rank only third in production; their combined gross exports comprise over 60 percent of the total. Australia and New Zealand together produce relatively little, but they are the second largest net exporters. The central plan countries, while first in production, are the second largest net importers in the three-year period, 1964–65 to 1966–67.

Consumption data are also given in table 2. The largest consumer is the U.S.S.R., followed by the EEC and South Asia. The actual wheat consumption by the large non-Communist exporting countries (United States, Canada, Australia, and Argentina) is relatively small.

As a finer breakdown, exports and imports for the leading countries are given in table 3. The five leading exporters (United States, Canada, Australia, U.S.S.R., and Argentina) accounted for roughly 85 percent of world wheat exports; the United States and Canada exported over 55 percent of the world total. The six largest importers (India, Communist China, United Kingdom, Japan, Brazil, and the U.A.R.) imported 45 percent of the wheat traded. India and Communist China accounted for roughly 20 percent of the imports. Imports are much less concentrated among countries than are exports.

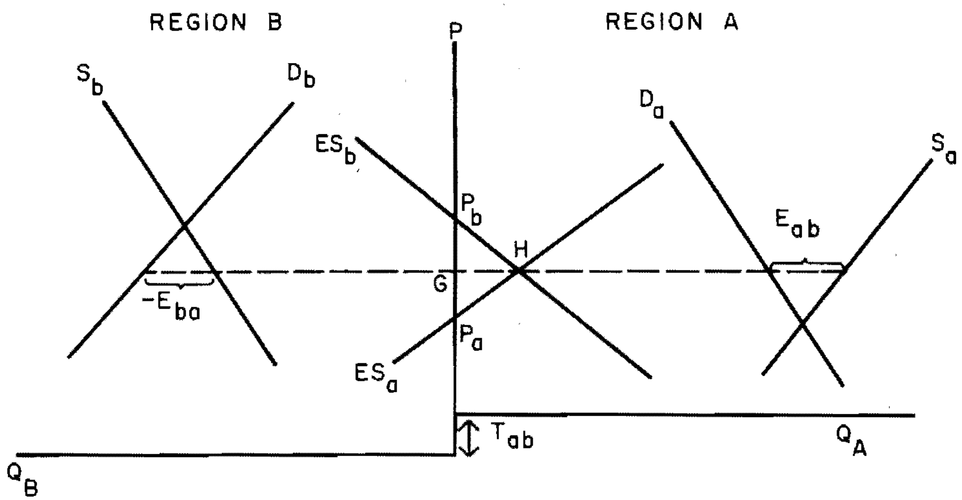

Fig. 1. A Spatial Price Equilibrium Model of Interregional Trade.

The Analytical Framework: A Spatial Equilibrium Model of Interregional Trade

Since this study is primarily concerned with determining the effects of space and domestic and foreign policies on wheat production, prices, and trade, it has the same emphasis as past studies in interregional economics.[3] But since wheat is an internationally traded commodity, standard interregional analysis must be modified to include policies, such as tariffs, which are imposed only on internationally traded goods. Therefore, developments in both interregional and international trade form the basis for the analytical framework used in this study. Specifically, a spatial price equilibrium model of interregional analysis is modified to analyze international trade in wheat.

The theoretical formulation used in studying interregional trade flows is presented diagramatically in figure 1.[4] It shows the equilibrium flow of exports from market A to market B for a two-region, one-commodity model. Before trade, equilibrium prices would be P_a and P_b for regions A and B, respectively, since the excess supply curves ES_a and ES_b are at their zero points. Once trade is allowed, the commodity will be exported from region A to region B due to the differential between P_a and P_b. Equilibrium is at H where the excess supply or exports of market A equal the algebraically negative excess supply or imports of market B. The bracketed distances, E_{ab}, $-E_{ba}$, and GH, are equivalent depictions of these flows.

This interregional model can also be used to represent international trading on a competitive, free-trade basis by letting the regions represent countries (or aggregates thereof) and quoting all prices and transfer costs in terms of a common currency.

The free-trade model for a single commodity is described in notation form below.

[3] For a bibliography of interregional analysis see Leuthold and Bawden (1966), and Weinschenck, Hendricksmeyer, and Aldinger (1969).

[4] This formulation follows that presented in Samuelson (1952, p. 286).

TABLE 3
COUNTRIES RANKED ACCORDING TO WHEAT EXPORTS AND IMPORTS ANNUAL AVERAGES, 1966-67 TO 1968-69

Country	Wheat	Percentage of world total
	1,000 metric tons	*per cent*
	Exports	
United States	19,290	35.91
Canada	10,812	21.23
Australia	6,446	12.65
U.S.S.R.	4,869	9.56
Argentina	2,405	4.72
Total	42,822	84.07
	Imports	
India	5,427	10.68
Communist China	4,281	8.43
United Kingdom	4,276	8.42
Japan	4,157	8.18
Brazil	2,515	4.95
United Arab Republic	2,408	4.74
Total	23,064	45.40

Source: International Wheat Council (1970).

Let:

Subscript i = consuming regions $1, \ldots, n$
Subscript j = producing regions $1, \ldots, m$
D_i = quantity consumed in region i
S_j = quantity produced in region j
DP_i = the (destination) price in consuming region i
OP_j = the (origin) price in producing region j
X_{ij} = quantity shipped to region i from region j

and

T_{ij} = transfer cost to region i from region j.

Given demand equations for each region,

$$D_i = a_i - b_i \, DP_i \qquad \text{for all } i;$$

supply equations for each region,

$$S_j = c_j + d_j \, OP_j \qquad \text{for all } j;$$

and transfer costs among all regions,

$$T_{ij} \qquad \text{between each } i \text{ and } j;$$

find:

$$DP_i, OP_j, D_i, S_j, \text{ and } X_{ij} \qquad \text{for all } i \text{ and } j$$

by maximizing:

$$f(P) = \Sigma_i\, a_i\, DP_i - \tfrac{1}{2}\, \Sigma_i\, b_i\, DP_i - \Sigma_j\, c_j\, OP_j - \tfrac{1}{2}\, \Sigma_j\, d_j\, OP_j$$

subject to:

$$\begin{aligned} DP_i - OP_j &\leqslant T_{ij} \qquad \text{if } X_{ij} = 0 \\ DP_i - OP_j &= T_{ij} \qquad \text{if } X_{ij} > 0 \\ D_i &= \Sigma_j\, X_{ij} \\ S_j &= \Sigma i\, X_{ij} \\ DP_i, OP_j, X_{ij} &\geqslant 0. \end{aligned}$$

Modifications of the Model

To be useful in empirical trade research, however, the above model has to be modified to incorporate international trade policies. It is necessary to remove the assumption of free trade. In addition, the model must be made more flexible in order to incorporate various domestic policies, such as price supports, which affect wheat production, pricing, and trade. The following examples indicate how the free-trade wheat model is modified in order to incorporate various domestic and foreign policies.[5]

Fixed import duty. Import restrictions in the form of fixed duty per physical unit are perhaps the simplest trade barriers to reflect in a spatial model. They can be simply added to those entries in the transport cost matrix corresponding to incoming shipments of the commodity to that particular country:

$$T_{ij} + \text{duty} \qquad \text{for all } i \neq j.$$

Ad Valorem import duty. Incorporating an ad valorem duty is not much more difficult, except that the duty is now a function of price. Destination and origin prices must differ by the transport cost plus the added tariff before other countries will ship to that nation. An ad valorem duty of g percent of the value f.o.b. origin could be represented as:

$$DP_i - OP_j = T_{ij} + (g)\ OP_j \qquad \text{for all } i \neq j$$

or

$$DP - (1 + g)\ OP_j = T_{ij}.$$

Variable import levy. While any of a number of different tariffs might be called a variable import levy, the one considered here is similar to that employed by the EEC—the EEC levy is the difference between a predetermined target price and the destination price established in the world market. To incorporate such a tariff in the model, the price of that commodity in the importing country must be fixed at the target price in all demand and supply equations in which it appears and a new constant term solved for each equation. The model is then solved without explicit recognition of the import duty, and the market value of the destination price of that commodity is determined. The levy charged all exporters of that commodity to the receiving nation will be the difference between the target price and the equilibrium value of the destination price.

[5] For a more detailed discussion and examples of the modifications, see Bawden (1966).

Fixed export subsidy. A predetermined export subsidy can be handled in the opposite manner of a fixed import duty by reducing the unit transfer cost on that commodity from the subsidizing nation to all recipient countries. However, negative figures will appear in the transportation cost matrix if the export subsidy exceeds some involved transport costs, and it may be necessary to restrain the subsidizing nation from exporting all its own production and importing from another country:

$$T_{ij} - \text{subsidy} \qquad \text{for all } i \text{ being subsidized}$$
$$\sum_j X_{ij} = 0 \qquad \textit{for all } i \neq j.$$

Fixed import quota. The model is first solved to determine if, with unrestricted trade, the import quota is exceeded. If so, a constraint is added that limits total imports to the predetermined figure:

$$\text{Quota} = \sum_j X_{ij} \qquad \text{for all } i \neq j.$$

Percentage import quota. An import quota based upon a percentage (let us say, g) of domestic production may be incorporated in the model by adding the constraint:

$$\sum_j X_{ij} = (g)\ S_j \qquad \text{for all } i \neq j.$$

First, however, the model must be solved in the absence of the constraint to see if the quota will be exceeded.

Bilateral quantity agreement. Agreements between two countries, such that one agrees to take a percentage (g) of its total imports from the other, may be represented as:

$$X_{ij} = (g) \sum_j X_{ij} \qquad \text{for all } i \neq j.$$

Domestic price support. Domestic price supports and acreage allotments are common agricultural policies in many countries. If a price support is in existence in some country, this price is merely fixed; and the appropriate demand and supply equations are revised before deriving the solution.

Domestic acreage allotment. If allotments are imposed on production of some commodity in a particular country, the model is first solved to see if equilibrium domestic production exceeds the allotment. If it does, the supply equation is no longer allowed to be a function of price but is made perfectly inelastic at the predetermined allotment level and the model is rerun.

The above modifications, while representing some of the more common policies affecting international trade, are by no means exhaustive. Many other trade barriers and intercountry relationships can also be incorporated in the model. For example, political constraints, such as the prohibition of trade between some Communist and Western countries or the assignment of specified commodity amounts under AID programs, can also be quantitatively represented.

The Programming Model

In order to use the previous international trade model for empirical analysis of the world wheat economy, a programming algorithm is used which is based on the analysis in figure 2. The same excess supply curves are represented as in figure

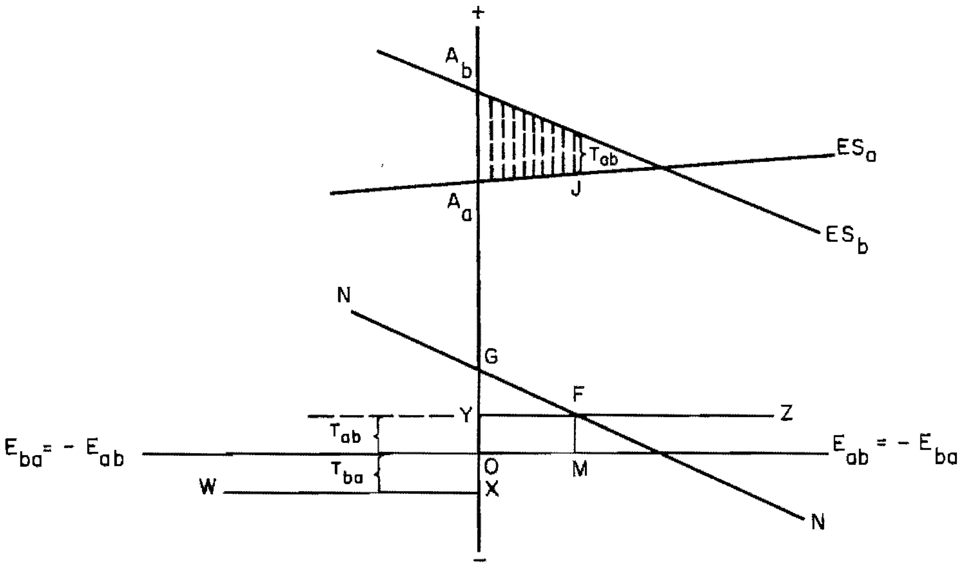

Fig. 2. Equivalent Depiction of Spatial Equilibrium.

1, but prices in regions A and B are measured from the same level rather than with one axis shifted by the amount of transfer costs; these enter at T_{ab}. Final equilibrium is at F where the two excess supply curves differ vertically by T_{ab}, and the net excess supply curve NN intersects the curve of discontinuous transport costs, WXYZ. Equilibrium exports and imports (E_{ab} and $-E_{ba}$) are shown by NN which represents the vertical distance between the two excess supply curves.

The maximization formulation for determining equilibrium prices and trade flows among countries consists of maximizing net social payoff which Samuelson defines, for any region, as the algebraic area under its excess supply curve which is equal in magnitude to the area under its excess supply curve but opposite in algebraic sign. In figure 2 total net social payoff equals the sum of each social payoff in regions A and B minus transport costs. Since NN measures the combined social payoff in both markets, net payoff equals OMFG or its equivalent, A_a and JKA_b, minus OMFY (transport costs).[9]

The algorithm used to analyze international trade in wheat is that developed by Takayama and Judge (1964). Their formulation maximizes Samuelson's net social payoff function referred to above. Their programming algorithm determines for each country equilibrium prices, production, consumption, and trade flows. In the solutions derived the shipping activity is perfectly competitive. If the transfer costs between any two countries exceed the difference in their equilibrium prices, they will not trade with each other. Conversely, if the difference in their prices exceeds transfer costs, sufficient trade will be induced to alter the prices so that the equilibrium price difference just equals their mutual transfer costs (after adjusting for import duties and export subsidies). Such conditions are consistent

[9] It should be emphasized that the maximization of a net social payoff function does not necessarily imply maximizing a "social welfare function." From figure 2, net social payoff is at a maximum under a policy of free trade. However, this may or may not be the best policy to pursue from a welfare point of view. Consequently, maximization of a net social payoff function is merely a mathematical formulation used to solve for equilibrium prices and trade flows.

with competitive behavior and the realized objective of every country to sell each product at its maximum price.

A Theoretical Model

A theoretical model of the world wheat economy can be developed within the spatial price equilibrium framework. A general model is first formulated to indicate the scope and complexity of the wheat economy. The model is then aggregated in order to make empirical analysis possible.

The general model, illustrated in figure 3, is summarized in notational form below. Subscript i refers to the five classes of wheat—hard red spring, hard red winter, soft red winter, durum, and white.

The following acreage equations, one for each class of wheat, attempt to reflect producers' decisions regarding how many acres to plant of each class of wheat:

$$A_i = f\ (P_{f1}, P_{f2}, P_{f3}, P_{f4}, P_{f5}, S_1, S_2, S_3, S_4, S_5, M, P_a, 1, F)$$

where

A_i = acreage seeded to wheat of class i; $i = 1 \cdots 5$

P_{f1} = farm price of hard red spring wheat expected in time $t+1$
$P_{f2} \cdots P_{f5}$ = same as above but for different classes of wheat
$S_1 \cdots S_5$ = farm stocks of each class of wheat at planting
M = moisture at planting
P_a = price index of alternative commodities that could be produced
1 = index of input prices

and

F = factors affecting acreage, such as government allotments and urbanization.

Corresponding to each of the five acreage equations is a yield equation. While yields are subject to producers' decisions, biological factors beyond the producers' control are of greater importance in determining final yield levels:

$$Y_i = f\ (P_{fi}, 1, T, W, D_i, G_i)$$

where

Y_i = yield per seeded acre
P_{fi} = farm price of class i wheat expected in time t + 1
1 = index of input prices
T = technology, including improvement of wheat varieties and changes in cultural practices
W = weather (rainfall, temperature, length of growing season, etc.)
D_i = diseases and insects

and

G_i = government factors affecting aggregate yields (for example, acreage controls).

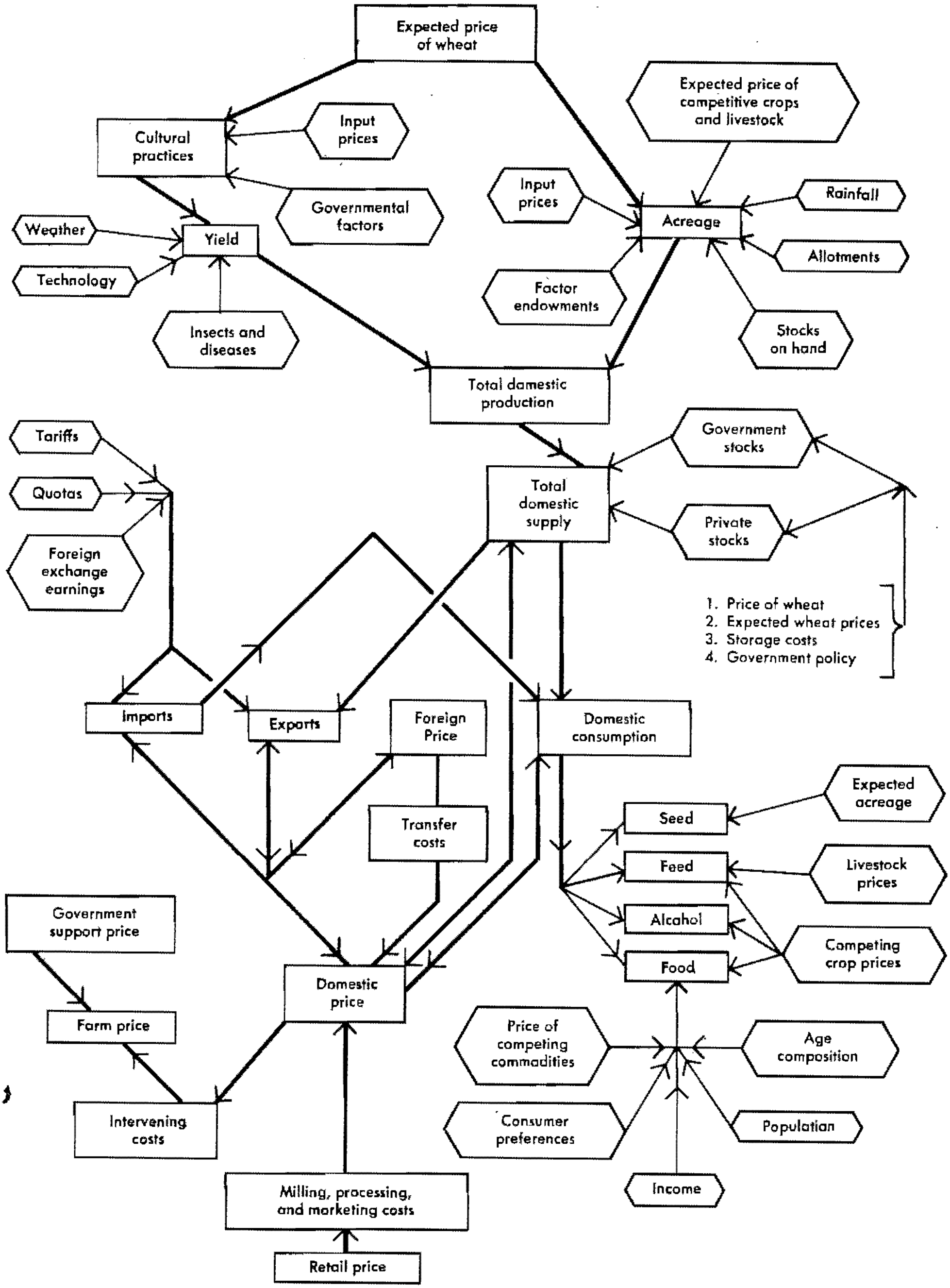

Fig. 3. The Physical, Economic, and Governmental Factors Determining the Structure of the Wheat Economy.

There are four demand equations—one each for food, feed, industrial, and seed use.

$$\frac{Ch}{L} = f\ (P_{m1}, P_{m2}, P_{m3}, P_{m4}, P_{m5}, P_c, N, N', O, A') \tag{1}$$

where

Ch = quantity of wheat consumed as food[7]
L = population of country
$P_{m1} \cdots P_{m5}$ = miller (wholesale) price of wheat for each of the five classes
P_c = price index of competitive nonwheat products used for food
N = per capita disposable income
N' = income distribution
O = tastes for wheat products

and

A' = age composition of population.

$$\frac{C1}{L} = f\ (P_{m2}, P_1, N, N', O, Q, S) \tag{2}$$

where

$C1$ = quantity of wheat used for industrial purposes
L = population of country
P_{m2} = miller price of hard red winter wheat
P_1 = price index of substitutable factors of production in making alcohol
N = per capita disposable income
N' = income distribution
O = tastes for wheat products
Q = quality of hard red winter wheat

and

S = stocks of wheat

$$\frac{CF}{Y} = f\ (P_{f3}, P_Y, P_F, Q, S', V) \tag{3}$$

where

CF = quantity of wheat used for livestock feed[8]
Y = livestock, especially feeder cattle
P_{f3} = farm price of soft red winter wheat
P_Y = livestock prices, especially feeder cattle prices
P_F = price index of other livestock feeds
Q = quality of wheat
S' = stocks of wheat on farms

and

V = feed conversion rate.

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[7] For a discussion of the factors affecting the demand for wheat as food, see Gruen *et al.* (1967) and Honan (1962).

[8] For a discussion of various factors to consider when projecting feed grain requirements, see Bjarnason (1967) and Regier (1967).

$$CS = f\ (A'_1, A'_2, A'_3, A'_4, A'_5) \qquad (4)$$

where CS is quantity of wheat used for seed and $A'_1 \cdots A'_5$ is expected acreage in $t+1$ of each class of wheat.

There are also five demands for stocks of the five classes of wheat:

$$S_i = f\ (P_{mi}, P'_{mi}, C_i, G_i)$$

where

S_i = demand for stocks of class i of wheat[9]
P_{mi} = present miller price of class i of wheat
P'_{mi} = expected future miller price of class i of wheat
C_i = cost of storing a unit of class i of wheat

and

G_i = government policies affecting the market of class i of wheat

The theoretical model developed above abstracts from data availability and research time constraints. Several simplifications (mostly via aggregation) are dictated by data scarcity, a few by the time constraint, and some merely because the explanatory power of the model is not seriously affected by simplifying it. The first and perhaps most significant simplification is that the five classes of wheat will be aggregated, and wheat will be viewed in estimation as a homogeneous commodity.[10] Data for most countries are not available to estimate either demand or supply equations for individual wheat classes. The consequences of not distinguishing among classes of wheat depend on the substitutability in use among classes. Since the demand for wheat by millers is the demand for factor inputs, the degree of substitutability among different classes of wheat depends on the technical conditions of production. This, in turn, depends on the flour blend favored by bakers and the final demand for bread and various bakery goods, since the blend differs depending on the final product. Consequently, the degree of subsituation varies among countries and among millers within a country.

To what extent different classes of wheat are substitutes is an empirical question. Kahlen (1962) and Wang (1962) conclude that hard red winter and hard red spring wheat grown in the United States are substitutes for one another in the manufacture of bread. They could not determine the substitutability of soft winter wheats because of inconclusive statistical results. No empirical studies have been made which determine the extent to which importers prefer different classes of wheat or the technical rigidities that exist in the world baking industry.

It appears that there is a large degree of substitutability among wheats in the manufacture of bread, and at least 90 percent of the wheat traded is used for bread and related bakery products; the remainder is used for highly specialized bakery products, macaroni, and other pastes. It is generally agreed, for example,

[9] The stock or inventory problem has been discussed extensively in the economic literature; for a bibliography, see Zusman (1962, p. 576).

[10] While, for estimation purposes, wheat is viewed as a homogeneous good, quality differences are taken into account in the equilibrium solutions by making adjustments in the transfer cost matrix.

that the United Kingdom requires high protein wheat from Canada to combine with its soft wheats. However, it appears that 95 percent of the flour mix can consist of any combination of wheats, including hard red and soft red winter wheats from the United States. Also, Japan has recently been developing a bread-making process capable of utilizing low-quality wheats. This would greatly eliminate any advantage which Canadian wheat has due to its superior quality. Separate markets do exist for durum and white wheats, but consumption and trade in these are negligible. Therefore, the consequence of viewing wheat as a homogeneous commodity in the present study is probably not seriously damaging.

A second simplification of the model is that separate demand equations are not estimated for the four uses of wheat—food, feed, industrial, and seed. Data are unavailable for many of the factors affecting industrial and feed uses (for example, prices of feed substitutes, wheat quality, and stocks of wheat and other grains stored on farms). For countries such as Argentina, there is no breakdown among different wheat uses. Perhaps this is not serious. As mentioned previously, 85 percent of the wheat consumed in the United States is in the form of food. For some countries, the percentage is higher; for others, it is less.

In lieu of estimating four separate demands, two alternative approaches are used. The first is to aggregate quantities of wheat and estimate a single equation. The second alternative is to treat feed, seed, and industrial consumption as exogenous, estimate a separate wheat-food equation, and merely add to this the levels of wheat consumed in the other three uses.

As a final simplification of the model, equations representing the demand for stocks will not be estimated because of insufficient data for most of the countries involved. Alternative levels will be assumed; hence, their determination will be exogenous to the model.

DATA COMPONENTS

The main data needed to apply the previous model empirically are (1) a delineation of the world wheat economy by producing and consuming regions, (2) costs of shipping wheat from producing to consuming centers, (3) wheat demand functions by regions, and (4) area supply relationships for wheat production. These are discussed in order.

Demand and Supply Regions

The world wheat economy is divided into 15 geographic regions. Individual demand equations are estimated for 11 of these: United States, Canada, Australia, Argentina, Japan, United Kingdom, Belgium-Luxembourg, the Netherlands, France, Italy, and West Germany. Except for the United States, supply equations are also estimated for these regions. A meaningful supply equation cannot be estimated for the United States because of acreage controls; supply is exogenous to the model, and equilibrium solutions are derived under alternative supply levels.

The rest of the wheat economy is separated into four large blocks—Africa, Other Europe (in this study, Other Europe includes the U.S.S.R.), Other Asia, and Other America. These four geographic divisions are not represented by wheat demand and supply equations but by point estimates of production and consumption. Most of the countries in these four regions, when viewed separately, have little effect on world trade and pricing of wheat. For the few large producers and

TABLE 4
WHEAT PRODUCTION AND CONSUMPTION CENTERS AND SHIPPING PORTS BY GEOGRAPHIC REGIONS

Geographic region	Production center	Consumption center	Shipping port
United States	Kansas City	St. Louis	Gulf
Canada	Regina	Toronto	St. Lawrence Seaway and Vancouver
Australia	Dubbo	Sydney	Eastern Australia
Argentina	Rosario	Buenos Aires	Rio del Plata
Japan	Tokyo	Tokyo	Tokyo and other
United Kingdom	London	London	Great Britain
EEC	Paris	Mannheim	Amsterdam-Antwerp-Hamburg
Other Europe[a]	Kiev	Kiev	Black Sea
Other Asia	Peking	Calcutta	Red China or India
Africa	Johannesburg	Capetown	Ghana or Nigeria
Other America	Mexico City	Rio de Janeiro	Rio de Janeiro and West Indies

[a]Includes the U.S.S.R.

consumers, principally the U.S.S.R. and Communist China, there are insufficient data to estimate demand and supply equations.[11]

In order to estimate the cost of shipping wheat among regions, production and consumption centers must be specified for each region as well as the ports through which wheat is shipped. Each region is represented by only one production center and one consumption center, chosen to be representative of its major wheat producing and consuming areas. These designations are listed in table 4. Although separate equations are estimated for each of the EEC countries, for policy analysis the EEC is viewed as a single region and represented by one production and one consumption center. While prices and policies in the past have been quite diverse among the EEC countries, they are expected to be much less so in the future because of the EEC's common agricultural policy. Viewing the EEC countries as one unit requires that their individual supply and demand equations be aggregated into a single supply and demand function representing the entire EEC.[12]

Wheat Transfer Costs

The cost of transferring wheat from one region to another is an aggregation representing several activities: (a) handling by the grain elevators, loading for transfer to the port, inland transportation, unloading at the port; (b) loading on an ocean-going vessel, ocean transportation, unloading at the port; (c) and loading for transfer to the consumption center, inland transportation, unloading, and further handling. For shipments from Canada to the United Kingdom, an example of the relative magnitude of these costs is shown in table 5.

Handling and freight costs for shipping wheat from Regina, Canada, to the St. Lawrence (the ocean port for shipping wheat to London) are 32.90 cents per bushel. This includes elevator handling, terminal storage, and administrative costs. The cost of loading ocean vessels at the St. Lawrence is ½ cent per bushel, which

[11] If data were available, it would be difficult to estimate supply and demand functions for the Communist countries since prices and the levels set for wheat produced (except for biological factors) and consumed are functions of the central plan authorities.

[12] The reason for estimating separate equations for each country was to avoid the problem of weighting such factors as prices and income by each of the members' contribution to output and total demand.

TABLE 5
COST COMPONENTS OF SHIPPING WHEAT FROM CANADA TO THE UNITED KINGDOM

Cost components	Cost
	cents per bushel
Handling and freight costs from production center to St. Lawrence port	32.90
Loading costs	.50
Ocean freight costs	20.93
Unloading costs	1.50
Handling and freight costs from London port to consumption center	2.04
Total transport costs	57.87

Source: Computed.

is 1 cent less than unloading at London. The ocean rate is 20.93 cents per bushel, and handling and freight costs within the United Kingdom are 2.04 cents per bushel.

Inland transportation, loading and unloading, and handling costs are unavailable for some countries. In these cases, estimates are made from known costs in other countries and adjusted when appropriate for differences in labor costs and other factors.

For some countries, several ports exist from which wheat is shipped. In Canada, the major ports are Vancouver, Churchill, and the St. Lawrence. In this study, the costs calculated from one country to another are the minimum attainable. Therefore, in determining the cost of shipping wheat from Regina to Tokyo, for example, the Vancouver port is used since this is by far the cheapest route. However, the St. Lawrence Seaway route is used when calculating shipping costs from Regina to the United Kingdom. Interestingly, the Pacific ports are not used in calculating shipping costs from the United States to Japan; because of the high inland transportation costs to the Pacific coast, it is cheaper to ship wheat to Japan via the Gulf ports (U. S. Economic Research Service, 1967).

Figure 4 indicates that rates for shipping wheat on ocean vessels vary substantially from month to month and year to year. Rates are negotiated separately for each cargo by the millers of the importing countries and the shipping companies. The rates vary, depending on the size of the ship, the volume of the shipment, the distance involved, the nature of the return cargo, and the season of the year. Also, the United States requires that wheat shipped to certain countries, including that shipped under P. L. 480, be transported in part or in whole by United States ships. This may result in higher or lower shipping costs for these cargoes than would otherwise be the case, depending on the degree of monopoly power of the shipping companies and the extent to which shipping is subsidized.

Since data are unavailable to construct an entire ocean transportation cost matrix using differentiated rates for these factors, aggregates of the various rates are constructed from monthly data for 1965. Among countries for which transportation data are unreliable or scarce, shipping costs are calculated on a per mile basis from other routes. Estimated costs of ocean transport are shown in Appendix table 1.

The total costs of transferring wheat from production to consumption centers are presented in matrix form in table 6. The matrix is not symmetrical because

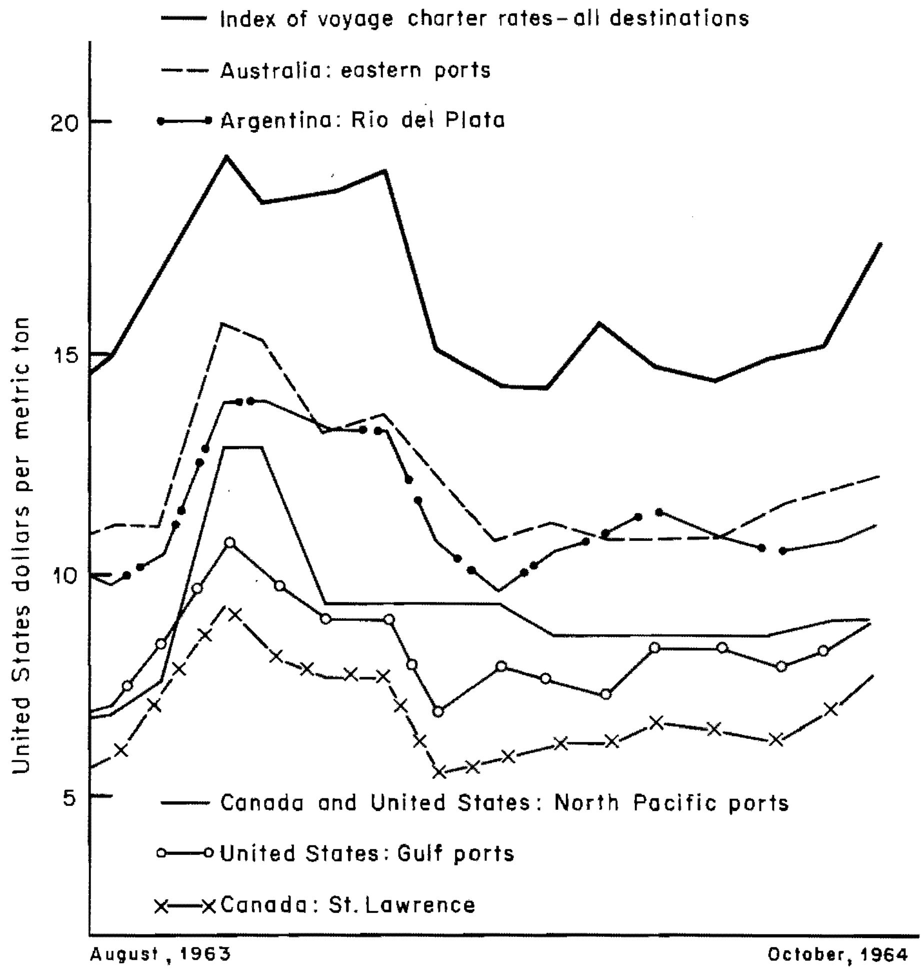

Fig. 4. Ocean Wheat Freight Rates to the United Kingdom from Selected Countries, August, 1963–October, 1964.
Source: International Wheat Council (1965–66, p. 48).

different points are used to represent production and consumption within most countries. For example, the total cost from Canada to Australia is 57.71 cents per bushel, but from Australia to Canada it is 99.39 cents per bushel. This is because of the greater distance from Dubbo to Toronto than from Regina to Sydney. Also, note that the estimated cost of shipping wheat from the United States to Japan is considerably larger than from Canada to Japan. This is partly because United States shipments from Kansas City to Tokyo are assumed to pass through the Gulf ports and partly because costs in the United States prior to ocean shipment are higher than in Canada.

Demand and Supply Relationships

Estimates of demand and supply for wheat are needed since a spatial price, international trade model is used as a framework for analysis. Wheat demand equations for individual countries have been estimated by Brandow (1961), Kahlen

TABLE 6

WHEAT TRANSPORTATION COST MATRIX—PRODUCTION TO CONSUMPTION CENTERS

From / *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe*	Other Asia	Africa	Other America
						cents per bushel					
United States	12.38	22.94	57.65	52.96	59.66	50.62	48.57	66.95	66.36	64.35	52.96
Canada	20.00	21.84	57.71	64.76	46.06	57.87	56.34	67.67	74.81	68.11	64.76
Australia	82.45	99.39	33.40	71.91	68.56	73.10	77.81	67.67	74.81	68.11	64.76
Argentina	59.36	68.50	53.51	16.46	75.63	56.84	60.44	62.98	71.46	66.10	36.63
Japan	59.66	74.14	43.76	69.83	13.60	35.22	51.35	52.56	42.28	41.61	42.51
United Kingdom	50.08	54.15	47.76	64.23	34.68	8.00	26.37	32.90	49.41	40.70	44.72
EEC	49.09	50.09	49.94	50.97	48.32	23.84	14.70	32.17	48.68	39.97	43.99
Other Europe*	67.31	65.21	40.99	57.30	53.28	34.16	40.29	8.63	43.24	45.91	55.96
Other Asia	76.27	81.54	39.86	74.96	52.18	50.82	47.59	47.43	18.51	51.21	69.29
Africa	70.18	70.76	39.28	65.53	47.44	47.07	51.86	51.02	52.13	14.43	66.86
Other America	52.96	61.58	47.20	63.04	71.30	59.99	61.43	55.24	64.38	61.03	8.63

*Includes the U.S.S.R.

Sources: U.S. Economic Research Service (1967); International Wheat Council (1966); Canadian Wheat Board (1944 through 1967); Searle Grain Co., Ltd. (1966); H. F. Bjarnason (1967).

(1962), Lehfeldt (1914), Meinken (1955), Gruen (1967), Schultz (1938, p. 65), Vigen (1965), Wang (1962), Wold and Jureen (1953), and Working (1917). Both least-squares and simultaneous equation estimation techniques were applied to per capita time series data. Kahlen and Wang estimated separate demand functions for the major classes of wheat in the United States. The remaining studies did not distinguish among the various wheat classes. Meinken's study was the only attempt at estimating separate equations for feed, industrial, and human use.

The studies by Allen (1954), Bowlen (1955), Candler (1957), Cromarty (1959), Duloy and Watson (1964), Farnsworth and Jones (1956), Oury (1963), Gruen (1967), and Schmitz (1968b), estimate wheat response relationships in selected countries. Most of the equations were estimated from aggregate time series data using least-squares regression. The exceptions are Cromarty's study which employed simultaneous equation estimating techniques, and Duloy and Watson's study which used an estimation method devised by Liviatan (1963). All studies viewed wheat as a homogeneous commodity, estimating a single equation for all classes of wheat combined.

Unfortunately, no one study has made estimates for several countries. Consequently, the equations are not consistent with respect to time, definition of variables, functional form, or data sources. Therefore, the authors' estimates of supply and demand functions are used.

Currency conversion. Because various countries have different currencies, a common currency must be chosen for the results derived from spatial equilibrium models to have any meaning. One cannot, for example, intersect a demand curve estimated in British pounds with a supply curve estimated in United States dollars. Either the programming model must have a built-in currency converter, or all currencies must be converted to one common denomination prior to estimating the equations. For convenience, the latter procedure is used. Time series data for supply and demand estimation, transportation costs, and policy data are all converted to a common currency. The United States dollar is selected since it makes up the largest part of international reserves. Also, the United States is the largest producer and exporter of wheat among the countries for which equations are estimated.

In countries where currency devaluation or appreciation has occurred over the estimated time period, it is necessary to select a base rate rather than yearly exchange rates for converting time series price data.[13] The reason for this is illustrated in figure 5 in which supply and demand equations for wheat are represented.

Before devaluation, Canada exports Q_1Q_2 of wheat to the United Kingdom at \$1.00 per bushel, which equals .5 British pound at the assumed exchange rate of \$1:\$1:.5£ (one United States dollar = .5 British pound prior to 1965). Suppose Canada devalues her currency 10 per cent in 1965, making the new exchange rate \$1:\$1.10:.5£. Now, Q_1Q_2 of wheat can be imported by the United Kingdom at .454£ per bushel. The decrease in cost per bushel for the United Kingdom causes

[13] As pointed out by Bjarnason, McGarry, and Schmitz (1969), one can convert each year's price into United States currency according to the exchange rate existing that year if the "purchasing power parity theory" is valid. This theory states that exchange rates move in accordance with real purchasing power in the trading nations. However, this has not been the case, for purchasing power has often varied between Britain and the United States for at least the last 15 years, yet the exchange rate has remained officially the same. In addition, countries may devalue for reasons other than inflation (for example, Canada in 1961). The theory itself has been criticized since there is no one price index to reflect purchasing power differences among countries.

an increase in quantity demanded of Canadian wheat, indicated by $D'_1D'_1$ (Canada's new total demand curve). This results in a new equilibrium price of $1.05 which equals .477£ at the new exchange rate. As is seen, the effect of devaluation causes Canada's domestic demand to decrease from Q_1 to Q_3, production to increase from Q_2 to Q_4, exports to increase from Q_1Q_2 to Q_3Q_4, and price to increase from $1.00 to $1.05.

Suppose Canada's supply and demand equations are estimated from time series data in which the last three observations (1963–1965) are 95 cents, $1.00, and $1.05 per bushel. Before estimation, these prices are converted to United States

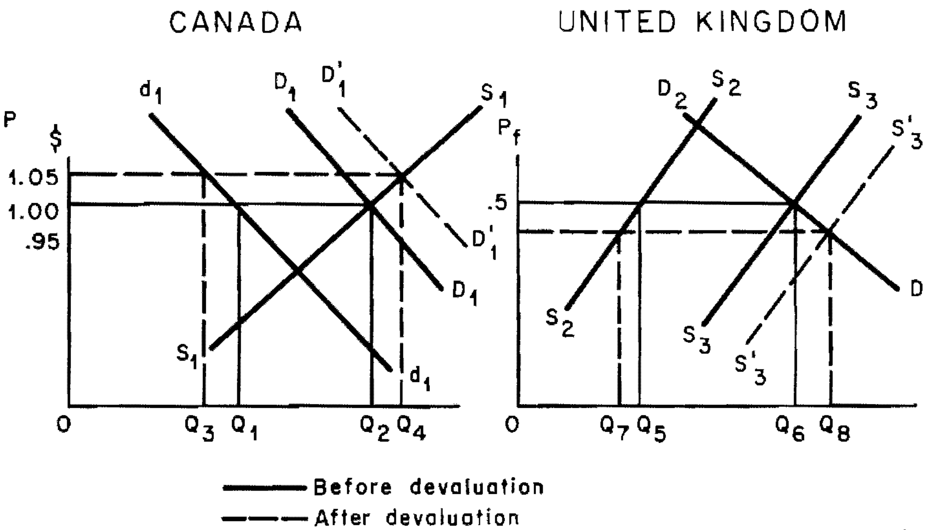

Fig. 5. Devaluation and Selection of Exchange Rates.

dollars. If the 1965 exchange rate ($1:$1.10:.5£) is used, the three prices become 86.4 cents, 90.9 cents, and 95.4 cents per bushel. However, if yearly exchange rates are used, the price series becomes 95 cents, $1.00, and 95.4 cents since the exchange rate in 1963 and 1964 prior to devaluation was $1:$1:.5£. The use of yearly exchange rates reflects a decrease in domestic prices for 1965 which is clearly not the case; in the absence of inflation, the rise in Canadian prices that occurred over the three-year period can be properly reflected by the use of one exchange rate alone. Consequently, the exchange rate for a single year, 1965, is used in this study to convert the time series data used.

Wheat demand.[14] There are insufficient data to estimate separate demand equations for each of the four uses of wheat—food, feed, seed, and industrial. The aggregation is handled in two ways: (1) estimate a food-use equation and add to this predetermined quantities of wheat consumed in the other three uses and (2) estimate an all-use equation in which total wheat consumed in all four uses is the dependent variable. However, food-use equations are not estimated for Argentina and Belgium-Luxembourg; data are unavailable for the former, and the amount of wheat used for food in Belgium-Luxembourg is about identical to the total amount.

Wheat demand equations are estimated by least-squares regression analysis and

[14] For a detailed discussion of demand, see Schmitz (1968a, Chapter 6).

are presented in Appendix tables 2 and 3.[15] The price and income elasticities computed from the estimated food-use demand equations appear in table 7. The negative price elasticities are no greater than .45; they are less than .30 except for West Germany and the Netherlands. This suggests that millers have not responded a great deal to past price changes. Likewise, the negative income elasticities are less than .40, except for Australia (.59), indicating, as expected, that consumers' purchases of wheat products are not highly sensitive to income changes. Rising

TABLE 7
PRICE AND INCOME ELASTICITIES OF DEMAND FOR WHEAT AS FOOD BY COUNTRY[a]

Country	Price elasticities	Income elasticities
United States	−.035	−.347
Canada	−.256	−.075
Australia	−.204	−.590
Japan	−.140	.352
United Kingdom	−.285	−.365
France	−.112	−.256
Italy	+	−.045
West Germany	−.412	−.209
Netherlands	−.431	−.055

[a]Elasticities are computed at the mean value for price and income.

Sources: Elasticity figures are published in John E. Hutchison, James J. Naive, and Sheldon K. Tsu (1970); the estimated demand equations from which these are derived are given in Schmitz (1968a, Chapter 6).

wheat prices coupled with rising incomes and an apparent negative income elasticity for wheat have resulted in a decline in per capita consumption. The one exception is Japan where per capita consumption has increased largely because the growth in income is positively correlated with wheat consumption.[16]

Unfortunately, not all of the income and price elasticities are directly comparable among countries since different measures of income are used. For example, the income measure used for EEC countries is per capita consumption expenditure; whereas, for Canada and the United States, it is per capita disposable income. A one percent increase in disposable income would result in a smaller change in consumption than would a one percent increase in per capita consumption expenditure. The price elasticities are comparable except that price changes over the data range may well vary among countries, resulting in different estimated coefficients even though the millers in different countries may respond the same, given similar price changes.

The price and income elasticities computed from estimated equations for all wheat uses are contained in table 8. The addition of a time variable in the estimated

[15] The demand equations are estimated in linear form for two reasons: (1) the programming algorithm specifies linear equations, therefore, if nonlinear equations are estimated, they must be approximated linearly (the errors introduced by linear approximations may well be as large as those obtained by direct linear estimation); and (2) scatter plots of the data indicate no discernible curvilinear relationships.

[16] In making intercountry comparisons it is difficult to reconcile, for example, a United States income elasticity for food use five times that for Canada in view of their similar standards of living. Significantly, the relationship is just reversed for their price elasticities, perhaps indicating problems of multicollinearity.

equations (from which the first set of elasticities is derived for each country) increased the price elasticities of three countries by nearly 450 percent for Japan, 100 percent for the United States, and 50 percent for France. The price elasticity for Argentina remained unchanged, and it declined for the remaining countries—60 percent for Belgium-Luxembourg, 33⅓ percent for Canada, less than 20 percent for four other countries, and from positive to slightly negative for the Netherlands.

TABLE 8
PRICE AND INCOME ELASTICITIES OF DEMAND FOR ALL WHEAT USES BY COUNTRY*

Country	Price elasticities	Income elasticities
United States	− .150	.750
	− .075	− .901
Canada	− .082	−1.420
	− .125	− .832
Australia	− .549	.449
	− .678	− .079
Argentina	−1.484	− .255
	−1.484	− .080
Japan	−3.030	.704
	− .704	.211
United Kingdom	− .013	− .328
	− .015	− .336
France	− .455	−2.003
	− .307	.202
Italy	− .023	− .0003
	− .027	− .0004
West Germany	− .558	− .216
	− .563	− .202
Belgium-Luxembourg	− .079	− .117
	− .202	− .269
Netherlands	− .030	− .917
	+	− .186

*Elasticities are computed at the mean value for price and income. The first set of price and income elasticities presented for each country is derived from an estimated equation, including a trend variable.

Sources: Elasticity figures are published in John E. Hutchison, James J. Naive, and Sheldon K. Tsu (1970); the estimated demand equations from which these are derived are given in Schmitz (1968a, Chapter 6).

Turning to the income elasticities, the time variable had a similar magnitudinal effect in the opposite direction for several of the countries. However, in the cases of Argentina, Japan, and the Netherlands, the elasticity increased substantially; and it changed from negative to positive for the United States and Australia. France's income elasticity changed dramatically, from +0.2 to −2.0.

Comparing the food-use price elasticities of table 7 with those for all wheat uses in table 8 we see less variation among countries in the former. However, except for the all-use elasticities for Argentina and Japan, all of the negative price elasticities in both tables are less than .70; and most of them are quite inelastic.

The income elasticities for all uses exhibit greater variation among countries, between equations with a trend variable and those without, and in comparison with the food-use income elasticities. While per capita demand for wheat used as food is generally decreasing due to increasing incomes (as indicated by the negative income elasticities for food use in table 8), the per capita consumption for all uses is rising in some European countries due to an increase in the amount used for feed.[17] This results in a substantial deviation between the food-use income elasticities and the all-use elasticities without a time variable and between the two all-use elasticities themselves. France is a good example. Its food-use income elasticity is negative (–.256), but the comparable all-use elasticity (the one without a trend variable) is positive (.202). Since time and income are closely correlated, if the trend variable is excluded, the increase in all-use wheat consumption (due to rising feed use) is reflected in the income coefficient, despite the fact that income has little, if any, influence on the amount of wheat used for feeding livestock. When a trend variable is introduced in the all-use equation, the income elasticity becomes negative.

On the other hand, there are substantial differences between the all-use income elasticities with a time variable and the food-use elasticities. Because the latter do not have a time variable the income variable is reflecting some other factor—for example, changes in tastes—that would otherwise be represented in a trend variable. (Recall that a trend variable was tried for the food-use equations but was rejected because it resulted in a positive price coefficient in most cases.) So the problem of intercorrelation among the income, price, and trend variables takes its toll from all of the demand equations, both food use and all uses.[18]

Wheat supply.[19] Wheat acreage and yields are estimated separately by least-squares regression. Those estimates are then combined to obtain a total supply response equation. Acreage planted and yields are determined largely by different factors. The decision of how many acres to plant is an economic one; yield, on the other hand, is influenced much more by biological and meteorological factors—insects, diseases, rainfall, and frost—than by economic forces.

Acreage response. Three general types of acreage equations, which are presented in Appendix table 4, are estimated: (1) a simple price lag model in which wheat acreage is the regressand and the expected price for time t is equal to the actual price in $t-1$, (2) a simple price lag model where the regressand is a ratio of wheat acreage to total cultivated acreage available in the region,[20] and (3) a price adjustment, distributed lag model as used by Nerlove (1958). However, the three different types of equations were not estimated for each country. For example, for certain countries it did appear necessary to estimate an acreage ratio model since the amount of land available for wheat production had not noticeably decreased.

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[17] The amount of wheat used for seed and industrial purposes, in addition to being a small part of all-use demand, shows no systematic change.

[18] Meinken (1955) obtained by least-squares estimation a price and income elasticity of –.04 and .20, respectively, for the United States per capita demand for wheat used as food. The price elasticity of –.035 obtained in this study is similar, but the income elasticity of –.347 is not. Vigen (1965) estimated for the EEC countries separate per capita demand equations for food and all wheat uses. For food-use demand, Vigen obtained all positive income coefficients except for the Netherlands, and the price coefficients were positive except for France and Italy. In this study the income and price coefficients are negative for all EEC countries except Italy. For all wheat uses, Vigen obtained positive income coefficients except for Belgium-Luxembourg, while the price coefficients were estimated negatively except for the Netherlands. A possible source of discrepancy in the elasticities estimated in this study and those obtained by Vigen is that, in both demand for food and all uses, Vigen included an extra variable—the wages of factory workers in the food-use equations and a consumer price index in the all-use equations.

[19] For a detailed discussion of wheat supply functions, see Schmitz (1968a, Chapter 5).

[20] This type of equation was estimated for regions in which total land available for cultivation has been noticeably decreasing (principally due to urbanization) or increasing (due to plowing up grassland or improving previously unsuitable land through irrigation).

The wheat price elasticities computed from the estimated acreage equations are given in table 9. Price elasticities with respect to acreage may be considered approximations of the more common elasticities with respect to supply. If yield per acre remains constant while acreage varies, they are the same. More likely, yield will decrease slightly as acreage increases (because of limited capital for purchasing fertilizer and other inputs and because the added acres may be of inferior quality) and vice versa. Thus, acreage price elasticities are probably slightly larger than supply price elasticities.

Also, interpretation of the elasticities must be made with reference to the data used for estimation. In many cases, the data are poor with respect to large, independent movements of the regressors. A low price elasticity suggests that farmers are unresponsive to price changes, however, this depends on the variation in price over the data range. To illustrate, if the price of wheat moves steadily from $1.50 to $1.65 per bushel in 15 years, farmers may respond little to this yearly price change of 1 cent per bushel. A quite different response, however, would be expected if price changed 15 cents per bushel in one year. The implication of this for making intercountry comparisons is that prices in one country may have changed considerably more than in another, resulting in different coefficients than if prices had changed by equal amounts. Intercountry comparisons are also complicated by inaccurate and unavailable data; for some countries important variables had to be excluded from the equations (for example, weather), and for others the included variables were measured differently (for example, seeded acreage versus harvested acreage).

TABLE 9

WHEAT PRICE ELASTICITIES COMPUTED FROM THE ESTIMATED ACREAGE EQUATIONS BY COUNTRY*

Country	Simple lag model	Distributed lag model	
	Elasticity	Short-run elasticity	Long-run elasticity
Canada	.863 .873	.559 .565	1.186 1.354
Australia	.817 .868	.398	3.538
Argentina	.696 1.310		
Japan	.223 .216†		
United Kingdom	1.360 .344†		
France	.089 .214	.051	.109
Italy	.219 .144†	.118	.438
West Germany	.155		
Belgium-Luxembourg	.747 .314†		
Netherlands	1.527 1.040†		

*The elasticities are computed at the mean values for price and acreage.

†Derived from estimated equations in which the regression is the ratio of wheat acreage to total cultivated acreage.

Sources: Elasticity figures are published in John E. Hutchinson, James J. Naive, and Sheldon K. Tsu (1970); the estimated acreage equations from which these are derived are given in Schmitz (1968a, Chapter 6).

Wheat acreage price elasticities in table 9 vary considerably, both within and among countries. Considering only those derived from equations using the simple lagged price expectation model, the range is from .089 for France to 1.527 for the Netherlands. Of the nine countries for which two estimates are shown, one elasticity is roughly twice the other in four of them. In general, the elasticities suggest that farmers in Canada, Australia, Argentina, and the Netherlands are more responsive to wheat price changes than those in Japan, France, Italy, and West Germany. Belgium-Luxembourg falls somewhere in between, and the United Kingdom is difficult to categorize (though elasticities of three of the four equations estimated for the United Kingdom ranged between .30 and .55).[21]

Yield estimates. Data limitations prevent measuring the effects which such factors as weather, insects, and diseases have on the behavior of wheat yields over time. Hence, forecasts are made by regressing yields against time. The results are given in table 10.[22] Except for the United States, the trend coefficients have the greatest statistical significance for the European countries, principally because fluctuations over time are smaller. Also, all European countries have trend coefficient values greater than 1, indicating that the average yearly increase in wheat yields over the data range is more than 1 bushel per acre. This is not the case for the other countries. Apparently, larger annual increases in yield in the European countries are due to recent intensification in the use of fertilizer and continuing improvement in crop rotation systems.

Among the non-European countries, the United States has the highest yearly yield increase of .67 bushel per acre. Japan experiences the lowest yield increase of .01 bushel per acre. Canada, the second largest wheat exporter, experiences the second lowest yield increase of .175 bushel per acre. Among the European countries, Italy has the highest yearly increase of 2.26 bushels per acre. Belgium-Luxembourg, the smallest wheat producer, experiences the lowest yield increase of 1.06 bushels per acre.

One might question the relatively larger yearly yield increase in bushels per acre in the United States (.67) compared with Canada (.175) and that of Argentina (.64) with Australia (.40). These differences may be due more to weather than to the rate of technological development since the countries are somewhat similar in their stage of agricultural development. The same might be argued for the European countries.

Obviously, there are problems in projecting yields into the future from a data base of ten or eleven years. For example, Italy has the lowest past mean yield of the five EEC countries; but it is projected to have the third highest yield by 1980, nearly 19 bushels per acre above France. The possibility of this occurring appears remote.

Also, United States yields are projected to exceed Canada's by 12.5 bushels per acre, but there has been an average difference of only 3.1 bushels per acre over the past 11 years. Such a gap is unlikely to exist by 1980. It also appears unrealistic for Japan's wheat yields in 1980 to be less than .50 bushel per acre above the average of her past yields.

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[21] Unfortunately, studies with which these elasticities can be compared are available only for Australia and France. The wheat price elasticities estimated by Duloy and Watson (1964) for Australia are similar to those obtained in this study. Their estimates, using the simple lagged model, are .480 and .893. In this study the corresponding elasticities are .817 and .868, respectively. In the Australian study the short-run elasticities, based on the distributed lag model, are .131 and .505; the long-run elasticities are .596 and 7.950. In this study the short-run elasticities are .398 and 3.538, respectively. Oury (1963) presents four acreage equations for France, but they are not directly comparable with the ones in this study.

[22] The forecasts from these equations are given in column 1 of table 11.

In view of these seemingly unrealistic projections, yield equations for Canada, Australia, and Argentina are reestimated, deleting one outlying observation in each time series.[23] These new equations, along with the yield projections for the United States (table 10), are used for projecting yields to 1980 for the seven remaining countries referred to earlier.[24] For these, two sets of projections are calculated, using the mean yields. The first uses the average percentage (39.02) increase for the four countries, and the second uses the absolute increase of 8.14 bushels per acre. Both the average percentage increase and the average of the absolute bushels per acre increase are applied to the mean yields for each of the seven countries in order to obtain their 1980 projections. The 1980 yields based on these measures are given, respectively, in columns 2 and 3 of table 11.

TABLE 10
WHEAT YIELD ESTIMATIONS AND PROJECTIONS TO 1980, BY COUNTRY

Country	Equations*	1980 projections	Mean yields	Time series	R_2	D.W.
	bushels per acre					
United States	$y = 17.72 + .6699T$ (.205)[a]	35.81	22.78	1954-1964	.5431	2.39
Canada	$y = 18.61 + .175T$ (.263)	23.34	19.65	1954-1964	.2461	2.05
Australia	$y = 15.35 + .3990T$ (.2456)	26.12	15.34	1954-1964	.2268	2.76
Argentina	$Y = 17.15 + .6409T$ (.2909)[c]	34.45	20.99	1954-1964	.3502	0.88
Japan	$Y = 33.43 + .0099T$ (.0594)	33.70	33.49	1955-1964	.2401	2.23
United Kingdom	$Y = 40.92 + 1.835T$ (.3415)[a]	90.46	51.94	1955-1964	.7624	2.31
France	$Y = 29.93 + 1.225T$ (.3379)[a]	63.01	37.27	1954-1964	.5933	2.62
Italy	$Y = 20.83 + 2.256T$ (.326)[a]	81.74	34.37	1954-1964	.5421	2.69
West Germany	$Y = 40.21 + 1.139T$ (.3198)[a]	70.96	47.04	1954-1964	.5849	2.73
Belgium-Luxembourg	$Y = 47.87 + 1.055T$ (.3149)[a]	76.92	54.20	1954-1964	.5849	2.73
Netherlands	$Y = 51.71 + 1.565T$ (.4232)[a]	93.97	61.10	1954-1964	.6032	2.95

*The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the one per cent level of probability and "c" denotes significance at the 10 per cent level of probability. "y" is yield per seeded acre and "Y" is yield per harvested acre.

For comparison, consider the yields in column 2 of table 11 with those in column 1 of table 10. Those in column 2 of table 11 are substantially higher for Japan (46.56 versus 33.70 bushels per acre)[25] and slightly higher for Canada (27.73 versus 23.34 bushels per acre). The United States yield is the same; and yields are slightly lower (from 1 to 9 bushels per acre) for Australia, Argentina, West Germany, Belgium-Luxembourg, and the Netherlands. The revised projections are

[23] The outlying observation in each time series is the unusual weather conditions which significantly affect the estimated equations.

[24] Because of the apparent difficulties in forecasting yields, both the high and low projections in table 11 are used to derive equilibrium trade solutions.

[25] However, deleting the very low 1963 observation for Japan results in an equation yielding a 1980 projection of 51.50 bushels per acre, 5 bushels above the 46.56 figure of our alternative procedure.

approximately 11 bushels per acre less for France, 18 less for the United Kingdom, and 34 less for Italy.

Two other studies have also projected wheat yields into the future. Sorenson and Hathaway (1968) projected wheat yields for the EEC countries to 1975. (In this study these were extended to 1980 for purposes of comparison in column 4 of table 11.) Storey (1966) projected wheat yields to 1980 based on a moving average with 1934–1938 as the base period, and these appear in column 5 of table

TABLE 11
A COMPARISON OF 1980 WHEAT YIELD PROJECTIONS, BY COUNTRY

Country	1980 projections				
	Inde-pendent	Revised (high)	Revised (low)	Sorenson-Hathaway	Storey
	1	2	3	4	5
			bushels per acre		
United States	35.81	35.81	35.81		33.84
Canada	23.34	27.73	27.73		30.10
Australia	26.12	23.89	23.89		23.94*
Argentina	34.45	27.05	27.05		22.72†
Japan	33.70	46.56	41.56		40.34
United Kingdom	90.46	72.21	67.21		
EEC countries					
France	63.01	51.81	46.81	68.29	
Italy	81.74	47.78	42.78	39.79	
West Germany	70.96	65.40	60.40	61.60	
Belgium-Luxembourg	76.92	75.35	70.35	64.44	
Netherlands	93.97	84.94	79.74	80.14	

*Projection for Oceania.
†Projection for Rio de la Plata region.
Sources: Cols. 1, 2, and 3: Calculated. Col. 4: V. Sorenson and D. Hathaway (1968). Col. 5: G. Storey (1966).

11. The Sorenson-Hathaway projections are below those of the authors for all of the EEC countries except France. However, it appears that at least two of their estimates (Italy and Belgium-Luxembourg) are too low; Italy surpassed the 39.79 bushel per acre projection in both 1962 and 1964 and nearly equaled it in 1963, while Belgium-Luxembourg yields in 1964 were only slightly below the Sorenson-Hathaway 64-bushel projection. Storey's projections are fairly close to the authors' revised estimates, being slightly lower for the United States, Argentina, and Japan; about the same for Australia; and slightly higher for Canada.[20]

Demand and supply projections. Wheat prices, quantities, and trade flows are predicted for each country to the year 1980. Hence the estimated demand and supply equations and point estimates must be projected to 1980. Because of the programming algorithm, the quantity of wheat is expressed solely as a function of wheat prices.

In predicting demand, income for each country is regressed against time and projected to 1980 (the estimated equations and projections appear in Appendix table 5). These values are then multiplied by their corresponding coefficients and subtracted from or added to the constant terms of the estimated regression equations. The trend variable, where included, is also combined with the intercept after adjusting to 1980. Finally, for the food-use equations a quantity representing

[20] Because of the apparent difficulties in forecasting yields, both the high and low projections in table 11 are used to derive equilibrium trade solutions.

use for feed, seed, and industrial consumption (at their mean values) is added to the constant term.

The demand equations are still at a per capita level, however. To convert to total demand, necessary for the trade analysis, population for each country is projected to 1980 (Appendix table 6) and multiplied by both the intercept and the price coefficient of each equation. The projected total demand equations for food use only, with other consumption added, appear in table 12. The projected total demand equations for all uses are shown in table 13.

TABLE 12
TOTAL DEMAND FOR WHEAT FOR FOOD USE*
1980 PROJECTIONS, BY COUNTRY

Country†	1980 total demand equations
	1,000 bushels
United States	$Q_d = 637{,}808.46 - 11{,}876P_m$
Canada	$Q_d = 248{,}491.40 - 28{,}308P_m$
Australia	$Q_d = 113{,}488.78 - 9{,}042P_m$
Japan	$Q_d = 239{,}494.09 - 9{,}115P_m$
United Kingdom	$Q_d = 319{,}862.64 - 27{,}069P_m$
France	$Q_d = 323{,}369.94 - 3{,}025P_m$
West Germany	$Q_d = 304{,}878.91 - 27{,}474P_m$
Netherlands	$Q_d = 83{,}042.92 - 10{,}836P_m$

*Feed, seed, and industrial uses were added to the constant term of the estimated food-use equations.

†Projections are not computed for Italy since the demand equation was estimated with a positive price coefficient; equations were not estimated for Argentina and Belgium-Luxembourg.

TABLE 13
TOTAL DEMAND EQUATIONS FOR WHEAT ALL USES*
1980 PROJECTIONS, BY COUNTRY

Country	1980 total demand equations
	1,000 bushels
United States	$Q_d = 488{,}351.68 - 60{,}348.56P_m$
	$Q_d = 359{,}430.71 - 30{,}089.62P_m$
Canada	$Q_d = 91{,}537.83 - 11{,}565.02P_m$
	$Q_d = 112{,}127.64 - 17{,}541.03P_m$
Australia	$Q_d = 163{,}448.16 - 39{,}374.35P_m$
	$Q_d = 168{,}433.92 - 48{,}614.83P_m$
Argentina	$Q_d = 153{,}730.33 - .0269P_m$
	$Q_d = 104{,}649.70 - .0269P_m$
Japan	$Q_d = 367{,}652.44 - 67{,}755.71P_m$
	$Q_d = 682{,}696.47 - 292{,}094.96P_m$
United Kingdom	$Q_d = 265{,}942.06 - 1{,}779.63P_m$
	$Q_d = 374{,}192.80 - 2{,}062.48P_m$
France	$Q_d = 532{,}735.80 - 55{,}002.74P_m$
	$Q_d = 471{,}303.69 - 37{,}091.59P_m$
Italy	$Q_d = 325{,}019.18 - 2{,}878.34P_m$
	$Q_d = 329{,}843.51 - 3{,}366.19P_m$
West Germany	$Q_d = 356{,}298.69 - 54{,}083.26P_m$
	$Q_d = 357{,}877.66 - 54{,}653.06P_m$
Belgium-Luxembourg	$Q_d = 47{,}069.14 - 1{,}616.64P_m$
	$Q_d = 55{,}535.75 - 4{,}164.37P_m$
Netherlands	$Q_d = 79{,}653.41 - 898{,}229.00P_m$
	$Q_d = 1{,}759.27 + 13{,}789.09P_m$

*The dependent variable includes food, feed, seed, and industrial uses.

Supply equations for 1980 are constructed from the acreage equations and yield projections in the following manner: acreage equations are first converted to the form $A = a + b\ P_{f(t-1)}$ by fixing all independent variables other than P_f at their mean or projected levels. For example, the acreage equation for Canada was estimated to be $A = 3{,}203.12 + 13{,}386.78\ P_{f(t-1)} - .0153S + 436.55T$. Canadian wheat stocks, S, in 1980 are assumed to be approximately the same as the average level over the 18 year-period 1947–1964 for which the equation was estimated, or 275,294.9 bushels; and $T = 34$ years. Therefore, $A = 13{,}833.81 + 13{,}386.78P_{f(t-1)}$. This equation is then multiplied by the estimated 1980 Canadian yield of 27.73 bushels per acre to arrive at the 1980 supply equation for Canada.

For the acreage ratio equations, total arable land must be projected to 1980.

This is done by regressing arable land against time for each of the five countries involved (Japan, United Kingdom, Italy, Belgium-Luxembourg, and the Netherlands) and making linear extrapolations to 1980. The equations and projections are shown in Appendix table 7. The acreage ratio equation previously estimated is then multiplied by the projected quantity of total arable land before it is combined with yield.

In the case of the acreage equations involving a distributed lag, the conversion is made to a long-run acreage equation in the usual manner by assuming that $A_t = A_{t-1}$ in equilibrium. Hence, the two terms can be combined and all remaining coefficients in the equation divided by the coefficient of adjustment (1 minus the coefficient of lagged acreage):

$$A_t = b_0 + b_1 P_{f(t-1)} + b_2 A_{t-1}$$

$$(1 - b_2)\ A = b_0 + b_1 P_{f(t-1)}$$

$$A = \frac{b_0}{1-b_2} + \frac{b_1}{1-b_2} P_{f(t-1)}.$$

This equation is then multiplied by projected yield to arrive at a 1980 supply equation.

The supply equations for 1980, based on the simple lagged price expectation model (which includes the five acreage ratio equations), appear in table 14. Supply equations for 1980, based on the distributed lag expectation model, are in table 15. These equations are now in a usable form and will be incorporated later into the quadratic programming framework to arrive at equilibrium prices, quantities, and trade flows.[27]

For reasons discussed previously, conventional demand and supply equations are not estimated for Other Europe, Other Asia, Africa, and Other America. Instead, point estimates are made by regressing consumption and production against time. The demand and production results are presented in tables 16 and 17, respectively. In each region the demand for wheat has been increasing. An increase of roughly 25 percent over 1965 is projected for Other Europe, 10 percent for Other Asia, 50 percent for Africa, and 50 percent for Other America. Since Other Europe and Other Asia account for over 90 percent of the total demand in these four regions, alternative estimates will be considered for these two in deriving the equilibrium solutions.

Wheat production in Other Europe has been increasing over the 1958–1966 period at an average of four percent per year. The increase for Africa has been roughly one percent per year, and it has been about five percent for Other America. Other Asia is the only region to experience an overall decline in production, indicated by the negative trend coefficient of –46.36 (table 17), reflecting an average decrease of approximately two percent per year.[28] Other Europe's wheat production is projected to 5,695 million bushels, 800 million bushels above the previous 1966 high. Other Asia's production is projected to 1,306 million bushels,

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[27] Wheat price is lagged, but this does not mean that 1979 prices must be known to arrive at 1980 equilibrium solutions. Rather, the purpose is to predict the "normal" 1980 situation, that is, the wheat economy in equilibrium. Hence, it is assumed that $P_f(_t) = P_f(_{t-1})$, just as it was assumed that $A_t = A_{t-1}$.

[28] Due to the Green Revolution and the recent efforts in the Soviet Union to increase its agricultural productivity, Other Asia's production might well increase. Allowance is made for this possibility when deriving the equilibrium solutions in a later section.

TABLE 14
WHEAT SUPPLY EQUATIONS, BASED ON SIMPLE LAG MODEL
1980 PROJECTIONS, BY COUNTRY

Country	1980 supply equations
	1,000 bushels
Canada	$Q_s = 437{,}955.14 + 355{,}659.71P_{f-1}$
	$Q_s = 383{,}611.55 + 371{,}214.85P_{f-1}$
Australia	$Q_s = 49{,}228.45 + 151{,}771.74P_{f-1}$
	$Q_s = 164{,}839.81 + 161{,}411.11P_{f-1}$
Argentina	$Q_s = 70{,}602.66 + 323{,}371.12P_{f-1}$
	$Q_s = 115{,}269.36 + 777{,}763.18P_{f-1}$
Japan	$Q_s = 75{,}773.14 + 5{,}576.49P_{f-1}$
	$Q_s = 247{,}088.33 + 13{,}386.47P_{f-1}$
United Kingdom	$Q_s = 47{,}033.66 + 93{,}355.98P_{f-1}$
	$Q_s = 359{,}049.78 + 64{,}466.92P_{f-1}$
France	$Q_s = 493{,}823.91 + 25{,}541.29P_{f-1}$
	$Q_s = 291{,}435.39 + 61{,}500.02P_{f-1}$
Italy	$Q_s = 473{,}528.47 + 26{,}840.42P_{f-1}$
	$Q_s = 350{,}795.03 + 51{,}561.36P_{f-1}$
West Germany	$Q_s = 264{,}609.71 + 28{,}311.52P_{f-1}$
Belgium-Luxembourg	$Q_s = 10{,}176.77 + 11{,}868.38P_{f-1}$
Netherlands	$Q_s = -39{,}387.53 + 16{,}306.78P_{f-1}$
	$Q_s = 28{,}663.00 + 9{,}477.26P_{f-1}$

TABLE 15
WHEAT SUPPLY EQUATIONS, BASED ON DISTRIBUTED LAG MODEL
1980 PROJECTIONS, BY COUNTRY

Country	1980 supply equations
	1,000 bushels
Canada	$Q_s = -119{,}338.55 + 504{,}338.18P_{f-1}$
	$Q_s = -131{,}431.88 + 508{,}566.46P_{f-1}$
Australia	$Q_s = -275{,}600.06 + 553{,}776.10P_{f-1}$
	$Q_s = 527{,}478.13 + 31{,}232.00P_{f-1}$
Italy	$Q_s = 287{,}651.85 + 86{,}088.57P_{f-1}$
	$Q_s = 642{,}778.61 + 16{,}867.30P_{f-1}$

TABLE 16
WHEAT CONSUMPTION EQUATIONS AND PROJECTIONS TO 1980, BY REGION

Region	Equations°	1980 projections	R^2	D.W.
	million bushels			
Other Europe†	$Q_d = 3{,}341.96 + 72.31T$ (38.25)	4,932.98	.4168	2.71
Other Asia‡	$Q_d = 2{,}600.16 + 16.68T$ (26.41)	2,967.12	.0739	1.96
Africa	$Q_d = 273.14 + 14.18T$ (.1678)[a]	585.10	.9345	2.14
Other America§	$Q_d = 261.91 + 12.38T$ (2.89)[a]	534.27	.7889	2.68

°The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the one per cent level of probability.

†Excluding EEC and United Kingdom.

‡Excluding Japan.

§Excluding United States and Canada.

Source: International Wheat Council (1959 through 1970, annual issues).

a decrease of 600 million bushels from the 1963–1966 average. Africa's production is estimated to be 234 million bushels, only slightly above that previously grown; and production for Other America is projected to 279 bushels, almost 60 percent above the previous 1964 high.

The above procedure of predicting consumption and production is questionable in several ways, however. The low R^2 values and high standard errors of the trend

TABLE 17

WHEAT PRODUCTION EQUATIONS AND PROJECTIONS TO 1980, BY REGION

Region	Equations[a]	1980 projections	R^2	D.W.
	million bushels			
Other Europe†	$Q_S = 3{,}048.53 + 120.31T$ (86.69)	5,695.35	.2430	2.02
Other Asia‡	$Q_S = 2{,}326.12 - 46.36T$ $(16.44)^c$	1,306.20	.5698	2.15
Africa	$Q_S = 189.45 + 2.02T$ (4.42)	233.89	.0337	2.00
Other America§	$Q_S = 113.86 + 7{,}50T$ $(2.28)^a$	278.86	.6845	1.53

[a]The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the one per cent level of probability, and "c" denotes significance at the 10 per cent level of probability.

†Excluding EEC and United Kingdom.

‡Excluding Japan.

§Excluding United States and Canada.

TABLE 18

WHEAT PRODUCTION AND CONSUMPTION, 1980 EXPORT-IMPORT GAPS FOUR EXOGENOUS REGIONS

Region	Production	Consumption	Net exports	Net imports
		million bushels		
Other Europe*	5,695.35	4,932.98	762.37	
Other Asia†	1,306.20	2,967.12		1,660.92
Africa	233.89	585.10		351.21
Other America‡	278.86	534.27		255.41
Total	7,514.30	9,022.49	762.37	2,267.54

*Excluding EEC and United Kingdom.

†Excluding Japan.

‡Excluding United States and Canada.

Source: Computed from regressions in Tables 16 and 17.

coefficients indicate that time alone is not a very reliable indicator of production (nonlinear equations were also estimated with only slightly better results). Also, because of data limitations, the time series had to be restricted to 7 years, scarcely long enough to serve as a solid foundation for projecting 15 years beyond. For these reasons, alternative levels of production for the four regions will be considered in deriving the equilibrium trade solutions presented in a later section.

Since 1980 point consumption and production projections have been presented for the four exogenous regions, the 1980 export-import gaps can be calculated. These are given in table 18. Other Europe is projected as a net exporter of 762 million bushels. Other Asia, Africa, and Other America are projected as net importers of wheat, the total being 2,267 million bushels, of which Other Asia accounts for 73 percent.

EMPIRICAL RESULTS

The Basic Solution

First, the basic solution is presented, then solutions are computed using modifications of the basic data.[29] In choosing data for the equilibrium solutions it is necessary to focus on the major policies and issues which are likely to be of future concern to the world wheat economy. Merely to run all conceivable combinations of the data presented previously is economically unfeasible because of the vast number. Also, many of these solutions at best would be of academic interest only.

Since it is unlikely that by 1980 a condition of free trade in wheat will exist, the basic solution incorporates the following:

1. A common external tariff for the EEC of $2.90 per bushel.
2. Canada's supply intercept, decreased by 200 million bushels to allow for Canadian wheat sales to the U.S.S.R. and Communist China. Correspondingly, demand projection for Other Europe and Other Asia are each decreased by 100 million bushels since each is forced to import that amount from Canada.[30]
3. Shipping costs from Canada to the United Kingdom reduced by 10 cents per bushel giving Canadian exports an advantage in the United Kingdom market. Likewise, the cost of wheat shipments from the United States to Japan is reduced by the same amount.[31]

In addition, the supply equations underlying the basic solution (table 19) are derived using the low-yield projections (table 11, column 3). Also, the United States acreage controls are assumed to remain in effect; production is fixed at 1.5 billion bushels. The export-import figures presented in table 18 for the exogenous regions are used, except that the export figure for Other Europe is assumed to be 600 million bushels and not the 762.4 million bushels previously projected.[32] The demand figures used are those specified in table 18.

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[29] Since only one supply and demand equation for each region can be used in deriving an equilibrium solution, a choice has to be made regarding which of the previous estimation equations to include. The choice among equations is spelled out in detail by Schmitz (1968a). One set of acreage equations used in this section and contained in Appendix table 4 is: 33, 37, 46, 49, 51, 52, and 55. The derived supply equations are based on the high yield projections (column 2, table 11). The other set of equations used is based on the same acreage equations but low-yield projections (column 3, table 11). Unless otherwise stated, the equation used for Argentina is $70{,}602.66 + 161{,}411.11P_{f,t-1}$. Also, production for Japan and the United Kingdom is fixed at 50 and 100 million bushels, respectively. Demand equations 1 through 6, 8, 9, 16, 24, and 28 are used (Appendix tables 2 and 3). All but the last three are food-use equations with a predetermined quantity, added to represent feed, seed, and industrial uses. Since food-use equations were not estimated for Argentina, Italy, and Belgium-Luxembourg, these countries are represented in the basic model by total use equations.

[30] Incorporating bilateral trade agreements in this manner allows a region to be both a wheat importer and exporter—for example, the U.S.S.R. can import from Canada and yet Other Europe can be an exporter, which is not possible in a free-trade solution.

[31] Canada, because of its high-protein spring wheat, appears to have an advantage in the United Kingdom market; among the non-Communist regions, the United Kingdom is by far the largest importer of Canadian wheat, importing 86 million bushels during the 1963–64 crop year. On the other hand, Japan seems to prefer low-protein wheats, some of which are grown in the United States.

[32] This is done in order to give a more meaningful interpretation to the results. Since production is assumed to be less than that projected, the prices derived for such regions as Canada, Australia, and the United States are optimistic. For example, if the predicted prices are below those established by the Cereals Agreement, it is felt that it is important to be able to demonstrate that even these low prices are based on optimistic supply projections.

The results in table 19 show that, for the four largest wheat exporting regions[33] (United States, Canada, Australia, and Argentina), origin (producer) prices are less than $1.50 per bushel.[34] For Canada and Australia they are less than $1.25 per bushel. In none of the 11 (total world) regions are producer prices above $1.80 per bushel, except in the EEC where the target price of $2.90 per bushel is projected. In no case is destination (miller) price above $2.00 per bushel except in the EEC.

Since production equals consumption at the equilibrating prices, they are projected to be 11.62 billion bushels in 1980 for the total world regions. Production and consumption for Other Asia are 1.30 and 2.97 billion bushels, respectively. The corresponding amounts for Other Europe are 5.6 and 5.0 billion bushels. The two regions combined produce 6.91 billion bushels (59.5 percent of the total production) and consume 7.79 billion bushels (67 percent of the total consumption). The regions for which supply equations were estimated produce 4.15 billion bushels, which is 35.7 percent of world production. Among these, the United States, the EEC, and Canada are the largest producers (in that order), accounting for 3.38 billion bushels (81.4 percent of the total 4.15 billion bushels). Likewise, the regions represented by demand equations consume 2.53 billion bushels, which is 22.2 percent of the world total. Of this, the EEC and the United States consume 61.7 percent.

Of the total world production of 11.62 billion bushels, 2.62 billion are exported. Excluding Other Europe, which exports 22.9 percent of the total, the exporters in order of importance are the United States, Canada, Australia, Argentina, and the EEC; these export 880, 630, 263, 151, and 89 million bushels, respectively. The United States and Canada export 57.7 percent of the total, while the traditional four largest exporting regions (United States, Canada, Australia, and Argentina) together export 73.7 percent of the total. On the other hand, Other Asia imports 1.66 billion bushels, which is 63.5 percent of the export total (2.62 billion bushels). The United Kingdom and Japan, generally considered to be large importers, account for only 13.3 percent of total exports.

The specific trade flows generated by the basic solution are the following: (1) The United States exports only to Other Asia and Other America; (2) Canada exports to Japan, United Kingdom, Other Europe, and Other Asia; (3) Australia exports to Other Asia and Africa; (4) Argentina exports only to Other Asia; (5) the EEC exports only to Africa; (6) Other Europe exports only to Other Asia; (7) Other Asia is the largest importer from the United States and Canada; and (8) Africa is the largest importer of Australian wheat.

Wheat Production in the U.S.S.R.

In the previous solution (table 19), production in Other Europe was fixed at 5.6 billion bushels. It was pointed out that the U.S.S.R. is the largest world wheat

[33] In this section, areas or countries are referred to as regions.

[34] As demonstrated in Appendix table 8, *infra*, p. 73, figures in the body of table 19 and subsequent ones represent trade flows from designated regions on the left to those listed along the top. Origin and destination prices (which will differ according to the inland cost of transporting wheat from the production to the consumption centers) and total quantities produced and consumed appear at the bottom of each table.

TABLE 19

OTHER EUROPE, HIGH PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	619,635								779,110		101,260
Canada		207,720			174,155	173,820		100,000	181,605		
Australia			99,420						200	262,495	
Argentina				153,725							154,145
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	700,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.41	1.22	1.22	1.47	1.55	1.62	2.90†	1.54	1.79	1.76	1.75
Destination price‡	1.53	1.44	1.56	1.63	1.68	1.70	2.90	1.62	1.97	1.90	1.84
						1,000 bushels					
Consumption§	619,635	207,720	99,420	153,725	244,155	273,820	951,290	5,000,000	2,967,120	585,100	534,265
Production¶	1,500,005‖	837,300	362,115	307,870	50,000	100,000	1,040,005	5,600,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

producer (seeding approximately 160 million acres). With this large acreage and with changing technology, even a 2-bushel per acre increase in yields would increase their production by 320 million bushels. Solutions in Appendix tables 8 and 9 and in table 20 indicate the impact that changes of this nature would have on production, prices, and trade. Other Europe's production is decreased from 5.6 billion to 5.4 to 5.0 billion bushels (Appendix tables 8 and 9, respectively). These solutions indicate that for each 200 million-bushel decrease of wheat production in Other Europe, producer prices in the four large exporting regions increase by approximately 25 cents per bushel. The effects of declining wheat production in the U.S.S.R. are discussed more fully with reference to table 20. Other Europe's production is fixed at 5.2 billion bushels rather than the 5.6 billion bushel level (table 19). This decrease in production increases producer prices, except for the EEC, by approximately 50 cents per bushel.

Interestingly, 1980 world production totals do not change a great deal by reducing Other Europe's production from 5.6 to 5.2 billion bushels. Previously, production (which equals consumption) was 11.62 billion as compared with 11.57 billion bushels. This is because of the increase in supply forthcoming from other regions due to the increase in wheat prices. It is apparent that the extent of the increase in supply depends on the responsiveness of supply and demand to price changes. The more supply is price elastic and the more demand is price inelastic the greater will be the forthcoming supply. It can also be shown that the greater the price elasticities of both supply and demand the smaller the change in price resulting from an exogenous change in supply.

The increase in supply and the decrease in demand in Canada, Australia, and Argentina from the price rise (due to the decrease in Other Europe's production) cause exports from these regions to increase from 1.05 to 1.42 billion bushels. The increase in United States exports is only 6.1 million bushels since supply is assumed to be unresponsive to price changes; therefore the U.S. increase in exports is due to the decrease in domestic demand caused by the rise in internal prices. However, while the magnitude of world trade flows changes, the pattern does not.

Public Law 480 Shipments

Only effective demand equations are incorporated into the model. However, it is difficult to determine whether many of the wheat imports are a result of food aid programs. Because of the large shipments of wheat by the United States to India under P. L. 480 (267.7 million bushels from July, 1965, to June, 1966), possibly the demand of 2.97 billion bushels for Other Asia was projected from data which did not consist exclusively of commercial imports. To account for this, two solutions are derived, assuming the demand of Other Asia to be below the 2.97 billion-bushel level. The results in Appendix table 10 are derived with the demand of Other Asia fixed at 2.67 billion bushels; the equilibrium solution in table 21 assumes a demand of 2.47 billion bushels. Both of these solutions are discussed together with reference to table 20.

The solutions indicate that, for each 200 million-bushel decrease in the demand of Other Asia, producer prices, except those of the EEC, decrease by 25 cents per bushel. When Other Asia's demand is reduced by 500 million bushels (table 21), producer prices in the regions represented by supply and demand response equations fall below $1.50 per bushel (except for the EEC target price of $2.90). Total

1980 production is 11.57 and 11.13 billion bushels when the demand of Other Asia is fixed at 2.97 and 2.47 billion bushels, respectively. This decrease in production almost equals the reduction in Other Asia's demand because the drop in prices has a greater influence on supply than it has on demand. The price elasticities computed from the estimation demand equations are small; hence, a large increase in demand is not forthcoming when prices decrease by 65 cents per bushel due to the 500 million-bushel reduction in the demand of Other Asia.

Canada, Australia, and Argentina exported 835, 350, and 235 million bushels, respectively—a total of 1.42 billion bushels—prior to the demand decrease in Other Asia. After the demand decrease to 2.47 billion bushels, exports from Canada, Australia, and Argentina fell to 955 million bushels—a decrease of 470 million bushels. While the magnitude of trade flows changes due to a demand decrease in Other Asia the pattern of trade does not, except that Canada then exports to Africa also, while Australia ceases to export to Other Asia.

Sensitivity of Projections to Changes in Supply Equations

In the previous solutions, changes were made in the levels of supply and demand in the regions for which point projections were made. In the two solutions which follow, changes are made in the estimation of supply equations to determine how sensitive the previous results are to the specified supply parameters. Only the major exporters (United States, Canada, Australia, and Argentina) are considered. In each of the following models the same data are used as those underlying the results in table 20, except for the explicit introduction of supply changes.

Supply equation for Canada. Table 22 contains results in which the slope of the Canada supply equation is reduced by 100 million bushels and the intercept increased by that amount—that is, the supply equation is made more price inelastic. Producer prices increase by 10 cents per bushel due to the supply change. The 1980 projection differs by only 10 million bushels. Also, the pattern of trade does not change.

Supply equations for Australia and Argentina. In table 23 the supply intercepts for Australia and Argentina are each increased by 100 million bushels. Comparing the results with table 20 indicates that prices decrease by approximately 20 cents per bushel. The production changes have no effect on either trade patterns or total 1980 production projections. However, the increases in production in Australia and Argentina cause a reduction in Canadian production of 79 million bushels.

High Wheat Yields and Japan's Increased Demand

Two solutions are computed to determine how an increase in total world wheat yields would reduce producer prices and whether or not this price reduction could be offset by an increased demand in Japan. Except for the yield and demand changes, the data are those used to derive the equilibrium solution in table 21.

The impact of wheat yield changes. Table 24 contains the results from incorporating the high yield projections (table 11, column 2). This increases production in the EEC to 1.21 billion bushels. For the four largest wheat exporting regions producer prices are less than $1.10 per bushel. For Canada and Australia they are less than $1.00 per bushel. The prices paid by the millers are not above $1.60 per

Table 20

OTHER EUROPE, LOW PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	613,540								868,040		18,425
Canada		193,195			169,475	159,930		100,000	405,200		
Australia			94,780						87,675	262,490	
Argentina				153,725							236,980
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin Price*	1.92	1.74	1.74	1.98	2.06	2.13	2.90†	2.05	2.30	2.27	2.26
Destination price‡	2.04	1.95	2.07	2.14	2.20	2.21	2.90	2.14	2.48	2.42	2.35
						1,000 bushels					
Consumption§	613,540	193,195	94,780	153,125	219,475	259,930	951,290	5,000,000	2,967,120	585,095	534,265
Production¶	1,500,005‖	1,027,800	444,945	390,705	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 21

OTHER ASIA, LOW CONSUMPTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From / *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	621,160								756,875		121,970
Canada		211,350			175,325	177,295		100,000	104,040	21,670	
Australia			100,580							240,825	
Argentina				153,730							133,440
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	3,000,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.28	1.09	1.09	1.34	1.42	1.49	2.90†	1.41	1.66	1.63	1.62
Destination price‡	1.40	1.31	1.43	1.51	1.55	1.57	2.90	1.50	1.84	1.77	1.71
						1,000 bushels					
Consumption§	621,160	211,350	100,580	153,730	225,325	277,295	951,290	5,000,000	2,467,120	585,100	534,270
Production¶	1,500,005‖	789,689	341,405	287,170	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 22

CANADA, PRODUCTION CHANGE: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From / *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	612,255								886,790		960
Canada		190,130			168,490	157,000		100,000	367,950		
Australia			93,800						106,120	262,490	
Argentina				153,725							254,450
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	2.03	1.84	1.84	2.09	2.17	2.24	2.90†	2.16	2.41	2.38	2.37
Destination price‡	2.15	2.06	2.18	2.26	2.30	2.32	2.90	2.25	2.59	2.52	2.46
						1,000 bushels					
Consumption§	612,255	190,130	93,800	153,725	218,490	257,000	951,290	5,000,000	2,967,065	585,095	534,270
Production¶	1,500,005‖	983,570	462,410	408,175	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 23

AUSTRALIA AND ARGENTINA, PRODUCTION CHANGE: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	616,060								883,945		
Canada		199,200			171,410	165,670		100,000	312,740		
Australia			96,700						151,500	262,490	
Argentina				153,725					12,730		255,405
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.71	1.52	1.52	1.56	1.85	1.92	2.90†	1.84	2.09	2.06	1.84
Destination price‡	1.83	1.74	1.86	1.72	1.98	2.00	2.90	1.93	2.27	2.20	1.92
						1,000 bushels					
Consumption§	616,060	199,200	96,700	153,725	221,410	265,670	951,290	5,000,000	2,967,120	585,095	534,265
Production¶	1,500,005‖	949,020	510,690	421,860	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Table 24

HIGH WHEAT YIELDS; 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, \$2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	624,085								714,165		161,750
Canada		217,155			177,195	119,090		100,000	100,000		
Australia			102,805						46,750	152,065	
Argentina				153,725							93,655
Japan					50,000						
United Kingdom						100,000					
EEC						63,765	951,290			199,140	
Other Europe								4,900,000	300,000		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.03	0.89	0.85	1.10	1.21	1.29	2.90†	1.16	1.41	1.38	1.38
Destination price‡	1.16	1.11	1.18	1.26	1.35	1.37	2.90	1.25	1.60	1.53	1.46
						1,000 bushels					
Consumption§	624,085	217,155	102,805	153,725	227,197	282,855	951,290	5,000,000	2,467,115	585,095	534,265
Production¶	1,500,000‖	713,440	301,620	247,380	50,000	100,000	1,214,195	5,200,000	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

bushel in any of the regions except in the EEC where $2.90 is the target price. Prices decrease by approximately 20 cents per bushel when the high rather than the low wheat yields are assumed. For example, the price received by Canadian producers decreases from $1.10 to 90 cents per bushel.

Interestingly, 1980 total production is projected to 11.13 billion bushels (which also equals consumption) regardless of whether the low or the high wheat yields are used. This is because the initial increase in total production is offset by the production decrease in Canada, Australia, and Argentina due to falling prices.

Of the world total, Other Europe and Other Asia produce 6.5 billion bushels (58 percent), United States and Canada combined produce 2.2 billion bushels (20 percent), and the EEC produces 1.2 billion bushels (11 percent). These five regions represent approximately 90 percent of the total world wheat production.

Of the total wheat produced, 2.13 billion bushels are exported. Of the total exports, 1.37 billion bushels (64.5 percent) are shipped by the United States and Canada, while the EEC, Australia, and Argentina export 430 million bushels (26 percent). Of the total 2.13 billion bushels shipped, Other Asia imports 1.16 billion bushels (54.5 percent); Japan and the United Kingdom combined import 17 percent. Therefore, these three regions import over 70 percent of the total exports.

Wheat yield increases for the EEC change the world trade flows in the following manner: (1) total wheat exports from the traditional large exporters decline due to the 170 million-bushel increase in exports from the EEC; (2) Canadian wheat shipments to the United Kingdom decline since the United Kingdom imports some wheat from both Canada and the EEC and, under low EEC production, the United Kingdom imports wheat only from Canada in which case Canada no longer exports wheat to Africa; and (3) Australia exports wheat to Other Asia.

The impact of Japan's increased demand. It is interesting to determine whether or not a reasonable increase in Japan's demand for wheat could offset the reduction in producer prices due to the high yield projections. The constant term in Japan's demand equation is increased by 100 million bushels for the following reason: currently, the per capita consumption of wheat by Japan is by far the lowest among the regions for which estimated equations are derived. It is conceivable that Japanese per capita consumption could approach 3 bushels by 1980 due, for example, to less restrictive rationing policies. This is still well below that expected for the other regions for which estimated equations are derived.

Table 25 incorporates the high yield assumption and the above change in Japanese demand. The solution shows that producer prices in the four large exporting regions are below $1.25 per bushel. However, these are approximately 10 cents per bushel above the prices in table 24 which were derived from the same data except for the wheat yield changes. However, even with the increased demand of Japan, producer prices are still below those prior to the introduction of high yields. Comparing tables 21 and 25 suggests that the price decrease is approximately 10 cents per bushel. Therefore, even if the Japanese demand did increase above that projected (2 bushels per capita), using the estimated demand equation, the effect on producer prices could easily be dissipated by small yield increases.

TABLE 25

JAPAN, HIGH CONSUMPTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	622,560								736,400		141,040
Canada		213,530			276,025	71,515		100,000	100,000		
Australia			101,645						24,515	196,170	
Argentina				153,730							114,365
Japan					50,000						
United Kingdom						100,000					
EEC						107,890	951,290			155,035	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin Price*	1.16	1.02	0.98	1.22	1.34	1.42	2.90†	1.29	1.54	1.51	1.50
Destination price‡	1.28	1.24	1.31	1.39	1.48	1.50	2.90	1.38	1.72	1.66	1.59
						1,000 bushels					
Consumption§	622,560	213,530	101,645	153,730	326,025	279,385	951,290	5,000,000	2,467,120	585,095	534,265
Production¶	1,500,000‖	761,070	322,330	268,095	50,000	100,000	1,214,195	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Summary of 1980 Projections; EEC Target Price of $2.90 Per Bushel and United States Production of 1.5 Billion Bushels

The previous 1980 projected prices, production, consumption, and trade flows are briefly summarized in table 26. The prices are for producers in Canada and Australia and the United States. For each of the projected producer prices are the following corresponding data: (1) wheat exports for the United States, Canada, and Australia and Argentina—the four largest wheat exporters; (2) total 1980 world wheat exports, which equal imports; (3) total 1980 world wheat production, which equals consumption; and (4) the export-import gaps for Other Europe and Other Asia.

Table 26 indicates that: (1) producer prices in Canada and Australia range from 87 cents to $2.03 per bushel and those in the United States vary from $1.03 to $2.21 per bushel; (2) United States wheat exports vary from a low of 876 to a high of 890 million bushels, Canadian exports reach a high of 962 from a low of 496 million bushels, and the combined amounts for Australia and Argentina vary from 292 to 656 million bushels; (3) total world exports, equal to net imports, range from 2.1 to 2.7 billion bushels; (4) total world production, equal to consumption, increases from a low of 11.13 to 11.62 billion bushels; and (5) the export-import gap for Other Europe varies from +600 million bushels to zero, while for Other Asia it varies from a low of –1.16 to a high of –1.66 billion bushels.

United States Acreage Allotments

Previously, no attempt was made to determine how changes in United States acreage allotments affect world wheat prices and exports. In the above solution, assuming a projected wheat yield of 35 bushels per acre, the United States production of 1.5 billion bushels represents the production from 42 million acres.[35] In tables 27 and 28 showing United States production of 1.2 and 1.8 billion bushels (at the same yield per acre), 34.3 and 51.4 million acres, respectively, were required to produce these amounts. It is assumed that production beyond 1.8 billion bushels is sold for "soft currencies" and, therefore, does not directly affect commercial wheat exports. Table 27 indicates that producer prices in the major exporting regions are well above $2.00 per bushel when United States production is 1.2 billion bushels. However, when United States production is increased to 1.8 billion bushels (table 28), producer prices drop to less than $1.65 per bushel. The results show that a drop in production from 1.8 to 1.2 billion bushels increases producer prices by approximately 85 cents per bushel.[36]

While producer prices are greatly affected by different acreage control levels, world wheat production is not. The increase in United States production from 1.2 to 1.8 billion bushels changes world production very little—from 11.54 to 11.61 billion bushels, an increase of only 70 million bushels. This is similar to the earlier example of varying supply levels in Other Europe. Supply decreases in the endog-

[35] United States wheat acreage allotments have varied from 43 million acres in 1953 to 68 million acres in 1966. Therefore, from an acreage standpoint, 42 million acres is a low estimate. However, production has ranged from a low of 1.09 billion bushels in 1962 to a high of 1.50 billion bushels in 1967; consequently, if yields in the United States do not increase by 1980, the 1.5 billion bushel estimate is on the high side.

[36] These results can also be compared with those in table 20 which are based on the same data except that production in the United States is 1.5 billion bushels.

TABLE 26

SUMMARY OF 1980 WHEAT PRICE, PRODUCTION, CONSUMPTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

Producer price		Exports			World exports (equal net imports)	World production (equals consumption)	Export-import gap for:	
Canada and Australia	United States	United States	Canada	Australia and Argentina			Other Europe*	Other Asia†
U.S. dollars per bushel		*1,000 bushels*						
.87	1.03	876	496	292	2,126	11,146	+200	−1,161
1.00	1.16	877	548	335	2,423	11,437	+400	−1,361
1.09	1.28	879	578	374	2,120	11,127	+200	−1,161
1.22	1.41	880	630	417	2,716	11,616	+600	−1,661
1.35	1.53	882	681	459	2,311	11,305	+200	−1,361
1.48	1.66	883	732	502	2,606	11,384	+400	−1,661
1.52	1.71	884	750	682	2,606	11,380	+200	−1,661
1.74	1.92	886	835	588	2,598	11,572	+200	−1,661
1.84	2.03	888	793	623	2,593	11,568	+200	−1,661
2.03	2.21	890	962	656	2,597	11,557	0	−1,655

*Includes the U.S.S.R.
†Excludes Japan.

enous regions by almost the full amount of the increase in United States production because demand in these regions is not greatly affected by price. As a result, exports from three of the largest exporting regions—Canada, Australia, and Argentina—declined by almost the amount of the increase in United States exports. United States exports increased by 590.3 million bushels, while the combined decrease in exports from the three regions was 560.9 million bushels. This results in a loss of export revenue for the three regions of approximately $2.2 billion.

Tables 29 and 30 are presented to determine how wheat prices are affected by changes in production and demand in regions other than the United States in conjunction with changing United States acreage allotments. In these tables United States production is 1.2 and 1.8 billion bushels, respectively. The following data changes are used: (1) production in Other Europe is increased from 5.2 to 5.7 billion bushels; (2) the high yield projections are used; and (3) Japan's demand intercept is increased by 100 million bushels. These changes significantly affect world wheat prices. Producer prices in the major exporting regions decrease from over $2.00 per bushel (table 27) to less than $1.65 per bushel (table 29), given United States production of 1.2 billion bushels. However, when United States production is 1.8 billion bushels, producer prices drop from a high of $1.60 per bushel (table 28) to below 75 cents per bushel (table 30). The results in Appendix table 11, which are based on high yields, show that producer prices for the major exporters increase by approximately 50 cents per bushel if the production of Other Europe is 5.4 billion bushels instead of the projected amount of 5.7 billion bushels. However, even then, producer prices for two large exporters (Canada and Australia) are only approximately $1.00 per bushel.

Again, total world wheat production is not greatly affected by increased United States production from 1.2 to 1.8 billion bushels; comparison of tables 29 and 30 shows that total world production increases from 11.70 to only 11.77 billion bushels. Also, these figures are only slightly above those when low yields were assumed and the production of Other Europe was 5.2 billion bushels.

EEC Target Price of $3.30 Per Bushel

By 1980 it is conceivable that wheat in the EEC could be supported above $2.90 per bushel. To account for this, solutions are derived using a support price of $3.30 per bushel. Apart from the price change, the results in table 31 are based on the same data as table 20. When the price support level is $2.90 per bushel, projected production and consumption in the EEC are 1.04 billion bushels and 951 million bushels, respectively. Due to the target price change to $3.30 per bushel, production increases only slightly to 1.09 billion bushels and consumption decreases to 932 million bushels. Since the effect on production is small, the pattern of export trade is not affected. Likewise, producer prices in the major exporting regions are not greatly affected; the results show that prices decline by only 10 cents per bushel due to the increase in the EEC support price.

In table 32 the high yield projections are used. The change in production due to increased wheat yields causes prices to decline more than did the increase in the EEC price support. Whereas prices declined by 10 cents per bushel due to the EEC support price of $3.30 per bushel, the change in yields reduced wheat prices by 20 cents per bushel.

Table 27
UNITED STATES, LOW PRODUCTION; LOW WHEAT YIELDS: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.2 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	608,440								591,565		
Canada		181,045			165,565	148,310		100,000	592,230		
Australia			90,900						160,845	262,490	
Argentina				153,725					16,275		255,405
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,895	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	2.35	2.16	2.16	2.20	2.49	2.56	2.90†	2.48	4.73	2.70	2.48
Destination price‡	2.47	2.38	2.50	2.36	2.63	2.64	2.90	2.57	2.91	2.85	2.56
						1,000 bushels					
Consumption§	608,440	181,045	90,900	153,725	215,565	248,310	951,290	5,000,000	2,967,120	585,100	534,265
Production¶	1,200,005‖	1,187,150	514,235	425,405	50,000	100,000	1,040,005	5,200,005	1,306,200	233,895	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 28

UNITED STATES, HIGH PRODUCTION; LOW WHEAT YIELDS:
1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.8 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	618,110								1,101,340		80,550
Canada		204,090			172,985	170,350		100,000	237,505		
Australia			98,260						22,070	262,495	
Argentina				153,725							174,855
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.53	1.35	1.35	1.60	1.68	1.75	2.90†	1.67	1.91	1.89	1.88
Destination price‡	1.66	1.57	1.68	1.76	1.81	1.83	2.90	1.75	2.10	2.03	1.96
						1,000 bushels					
Consumption§	618,110	204,090	98,260	153,725	222,985	270,350	951,290	5,000,000	2,967,120	585,100	534,265
Production¶	1,800,000‖	884,930	382,825	328,580	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 29

UNITED STATES, LOW PRODUCTION; HIGH WHEAT YIELDS:
1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.2 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
	1,000 bushels										
United States	617,715								507,080		75,210
Canada		203,150			272,685	169,450		100,000	100,000	51,930	
Australia			97,960						253,835	36,370	
Argentina				153,725							180,200
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			262,905	
Other Europe								4,900,000	800,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
	U.S. dollars per bushel										
Origin Price*	1.57	1.38	1.38	1.63	1.71	1.78	2.90†	1.70	1.95	1.92	1.91
Destination price‡	1.69	1.60	1.72	1.80	1.84	1.86	2.90	1.79	2.13	2.06	2.00
	1,000 bushels										
Consumption§	617,715	203,150	97,960	153,725	322,685	269,450	961,290	5,000,000	2,967,115	585,095	534,270
Production¶	1,200,005‖	897,215	388,165	333,925	50,000	100,000	1,214,195	5,700,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 30

OTHER EUROPE, HIGH PRODUCTION; HIGH WHEAT YIELDS:
1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.8 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	628,390				55,745				760,915	134,685	220,270
Canada		222,345			223,120			100,000	100,000		
Australia			105,660							145,020	
Argentina				153,730							35,140
Japan					50,000						
United Kingdom						100,000					
EEC						191,395	951,290			71,505	
Other Europe								4,900,000	800,000		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	.67	.53	.53	.73	1.03	.97	2.90†	.80	1.05	1.07	1.01
Destination price‡	.79	.75	.87	.90	1.17	1.05	2.90	.89	1.23	1.21	1.10
						1,000 bushels					
Consumption§	628,390	222,345	105,660	153,730	328,865	291,395	951,290	5,000,000	2,967,115	585,100	534,270
Production¶	1,800,005‖	645,465	250,680	188,870	50,000	100,000	1,214,190	5,700,000	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 31

LOW WHEAT YIELDS: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $3.30 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	614,535								853,520		31,945
Canada		195,555			170,240	162,195		100,000	171,505	197,205	
Australia			95,535						335,885		
Argentina				153,725							223,460
Japan					50,000						
United Kingdom						100,000					
EEC							932,135			154,000	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.84	1.65	1.65	1.90	1.98	2.05	3.30†	1.97	2.22	2.19	2.18
Destination price‡	1.96	1.87	1.99	2.06	2.11	2.13	3.30	2.05	2.40	2.33	2.27
						1,000 bushels					
Consumption§	614,535	195,555	95,535	153,725	220,240	262,195	932,135	5,000,000	2,967,115	585,095	534,265
Production¶	1,500,000‖	996,700	431,420	377,180	50,000	100,000	1,086,135	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 32

HIGH WHEAT YIELDS: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $3.30 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	617,320								812,855		69,825
Canada		202,200			172,380	168,550		100,000	252,165	14,300	
Australia			97,655						295,890		
Argentina				153,725							185,580
Japan					50,010						
United Kingdom						100,000					
EEC							932,135			336,900	
Other Europe								5,000,000	300,000		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.60	1.42	1.42	1.67	1.74	1.82	3.30†	1.73	1.98	1.95	1.95
Destination price‡	1.73	1.64	1.75	1.83	1.88	1.90	3.30	1.82	2.17	2.10	2.03
						1,000 bushels					
Consumption§	617,320	202,200	97,655	153,725	222,390	268,550	932,135	5,000,000	2,967,110	585,090	534,265
Production¶	1,500,000‖	909,595	393,545	339,305	50,010	100,000	1,269,035	5,200,000	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 33

EEC TARGET PRICE OMITTED; HIGH WHEAT YIELDS:
1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS

From / *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	620,415								760,915	6,800	111,875
Canada		208,245			174,325	174,330		100,000	100,000	73,400	
Australia			99,590							259,480	
Argentina				153,725							143,535
Japan					50,000						
United Kingdom						100,000					
EEC							1,008,600			11,530	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin Price*	1.34	1.20	1.20	1.40	1.53	1.60	1.49†	1.47	1.72	1.74	1.68
Destination price‡	1.47	1.42	1.54	1.57	1.66	1.68	1.63	1.56	1.91	1.88	1.77
						1,000 bushels					
Consumption§	620,415	208,245	99,590	153,725	224,325	274,330	1,008,600	5,000,000	2,467,120	585,100	534,270
Production¶	1,500,000‖	830,300	359,070	297,255	50,000	100,000	1,012,130	5,200,005	1,306,200	233,890	273,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 34

EEC TARGET PRICE OMITTED; LOW WHEAT YIELDS:
1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	618,585						49,595		760,910		80,910
Canada		202,195			272,380	168,545	11,200	100,000	100,000	55,305	
Australia			97,655							295,905	
Argentina				153,725							184,495
Japan					50,000						
United Kingdom						100,000					
EEC							931,825				
Other Europe								4,900,000	300,000		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.50	1.42	1.42	1.66	1.74	1.82	1.83†	1.72	1.97	1.95	1.94
Destination price‡	1.62	1.64	1.75	1.82	1.88	1.90	1.98	1.81	2.16	2.10	2.02
						1,000 bushels					
Consumption§	618,585	202,195	97,655	153,725	322,380	268,545	992,615	5,000,000	2,467,110	585,100	544,265
Production¶	1,500,000‖	909,625	393,560	338,220	50,000	100,000	931,825	5,200,000	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

TABLE 35

EEC TARGET PRICE OMITTED; UNITED STATES PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	613,520								568,300		18,180
Canada		193,140			269,460	159,885	12,480	100,000	292,610	780	
Australia			94,765							350,425	
Argentina				153,725							237,225
Japan					50,000						
United Kingdom						100,000					
EEC							965,480				
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin Price*	1.92	1.74	1.74	1.99	2.06	2.14	2.15†	2.05	2.30	2.27	2.27
Destination price‡	2.05	1.96	2.07	2.15	2.20	2.22	2.30	2.14	2.49	2.42	2.33
						1,000 bushels					
Consumption§	613,520	193,140	94,765	153,725	319,460	259,885	977,960	5,000,000	2,467,115	585,095	534,265
Production¶	1,200,000‖	1,028,355	445,190	390,950	50,000	100,000	965,480	5,200,005	1,806,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

The results in Appendix tables 12 and 13 are based on the low and high wheat yield projections. The difference here from the above solutions is that the demand of Other Asia is decreased to 2.67 billion bushels. Producer prices in Canada and Australia drop by 40 cents to a low of $1.27 per bushel when the low yield projections are used and fall to approximately $1.00 per bushel when the high yield projections are used.

Eliminating the EEC Target Prices

The following are 1980 projections eliminating the EEC target prices. Table 33 contains the results, based on the data used for the solution in table 24 except for the target price. In table 33 United States sales are 1.5 billion bushels; Other Asia's imports and Other Europe's exports are set at 1,160 and 300 million bushels.

Prices in the non-EEC regions increase by approximately 30 cents per bushel due to the elimination of the EEC target prices. In the EEC producer prices drop to approximately $1.50 per bushel. As a result, the EEC exports only 11.5 million bushels as compared to the previous amount of 262.9 million bushels (target price of $3.30 per bushel). The increase in producer prices in non-EEC regions causes their production and exports to increase. Wheat shipments from the EEC to the United Kingdom are replaced by Canadian exports; EEC shipments to Africa are replaced by exports from both the United States and Canada.

Table 34 is based on the same data as table 33, except low yields are used and Japan's demand is increased by 100 million bushels for reasons mentioned earlier. EEC producer prices increase by 30 cents to $1.80 per bushel, while producer prices in Canada, for example, increase from $1.20 to $1.40 per bushel. Part of the ensuing increase in production and exports from the major exporting regions goes to the EEC. This is because the EEC is a net importer of 60.8 million bushels as a result of using the low rather than the high yield projections.

The results in table 35 are derived from the same data, except United States commercial sales are 1.2 billion instead of 1.5 billion bushels as originally assumed. Producer prices in the EEC increases to $2.15 per bushel. At this price the EEC becomes self-sufficient in wheat.

Summary of 1980 Projections; Alternative EEC Target Prices and United States Acreage Allotments

Briefly summarized in table 36 are the 1980 projected prices, production, consumption, and trade flows which have been derived using alternative EEC target prices and United States acreage allotments. The prices given are for producers in Canada and Australia and the United States. Along with each of these projected prices are: (1) wheat exports for the United States, Canada, and Australia and Argentina—the four largest wheat exporters; (2) total 1980 world wheat exports, which equal imports; (3) total 1980 world production, which equals consumption: and (4) the export-import gaps for Other Europe and Other Asia.

Table 36 indicates that: (1) producer prices in Canada and Australia range from 53 cents to $2.16 per bushel and those in the United States vary from 67 cents to $2.35 per bushel; (2) United States exports vary from a low of 582 million bushels to a high of 1,180 million bushels, Canada's exports reach a high of 1,006 million bushels with a low of 423 million bushels and the combined amounts for

TABLE 36

SUMMARY OF 1980 WHEAT PRICE, PRODUCTION, CONSUMPTION, AND TRADE-FLOW PROJECTIONS
ALTERNATIVE LEVELS OF EEC TARGET PRICES; ALTERNATIVE UNITED STATES ACREAGE ALLOTMENTS

Producer price		Exports			World exports (equal net imports)	World production (equals consumption)	Export-import gap for:	
Canada and Australia	United States	United States	Canada	Australia and Argentina			Other Europe*	Other Asia†
U.S. dollars per bushel		*1,000 bushels*						
.53	.67	1,172	423	180	2,738	11,768	+700	−1,661
1.00	1.16	1,177	548	335	2,723	10,642	+400	−1,661
1.04	1.21	878	555	353	2,323	11,213	+200	−1,361
1.20	1.34	880	622	402	2,116	11,167	+200	−1,161
1.27	1.45	881	648	431	2,314	11,293	+200	−1,361
1.35	1.53	1,182	681	460	2,612	11,603	+200	−1,661
1.38	1.57	582	694	470	2,709	11,702	+700	−1,661
1.42	1.60	883	708	481	2,609	11,581	+200	−1,661
1.42	1.50	882	708	480	2,270	11,243	+200	−1,161
1.65	1.84	885	801	558	2,598	11,560	+200	−1,661
1.74	1.92	586	835	587	2,209	11,198	+200	−1,161
2.16	2.35	592	1,006	694	2,581	11,535	+200	−1,661

*Includes the U.S.S.R.
†Excludes Japan.

Australia and Argentina vary from 694 million to 180 million bushels; (3) total world exports (equal to net imports) range from 2.72 billion to 2.12 billion bushels; (4) total world wheat production (equal to consumption) increased from a low of 10.64 billion bushels to a high of 11.70 billion bushels; and (5) the export-import gap for Other Europe varies from +700 million to +200 million bushels, while the corresponding gap for Other Asia varies from –1.16 billion to –1.66 billion bushels.

POLICY IMPLICATIONS

Spatial equilibrium analysis has three broad uses: (1) to predict the effects of policy changes; (2) to predict absolute levels of prices, production, consumption, exports, and imports among regions conditional on fixed policies and other variables; and (3) to examine the efficiency of the current and future international wheat trade pattern. This study has been concerned with the first two, and specific projections of these by country or region have been presented. The following draws on those results to discuss policy issues specific to the world wheat economy.

The International Cereals Agreement

Minimum and maximum prices have been established by Canada, United States, Australia, and Argentina for wheat sold in international markets. Historically, the prices were negotiated under various international wheat agreements. However, in 1967 the historical international wheat agreements were replaced by the International Cereals Agreement. The minimum and maximum prices set for the major exporting countries by this Agreement are given in table 37.

To what extent are the above prices consistent with those derived from the equilibrium solutions? When the EEC price is assumed to remain intact, only six of the solutions indicate that 1980 wheat prices will be above the minimum set in the 1967 Cereals Agreement. Of these, two solutions contain projected prices above the maximum. The corresponding quantity and value of wheat exports for Canada, Australia, and Argentina are given in table 38. These are presented since price projections by themselves are of little interest unless the corresponding value of exports is known. For the six price forecasts which are above the minimum established by the Cereals Agreement, the value of wheat exports ranges from $1.2 billion to $2.2 billion for Canada; from $630 million to $914 million for Australia; and from $418 million to $598 million for Argentina. It is the authors' belief that, unless drastic changes in supply and demand conditions occur in the future, the prices and accompanying exports are not likely to reach the levels indicated by the six solutions (in which prices are above the minimum set by the Cereals Agreement) for the following reasons: in each of the six solutions, (1) production in Other Europe is not assumed to be above 5.2 billion bushels (500 million bushels below that projected using past data); (2) United States production is not assumed to be above 1.5 billion bushels (at 35 bushels per acre, this represents an acreage allotment of 42.9 million, considered low in view of previous acreage allotments which have exceeded 60 million acres at times); and (3) low wheat yields are assumed, which seems somewhat unrealistic in view of the recent technological advances.

TABLE 37
INTERNATIONAL CEREALS AGREEMENT (1967), MINIMUM AND MAXIMUM PRICES
UNITED STATES GULF PORTS BASIS

Country	Negotiated prices: Minimum	Negotiated prices: Maximum
	U.S. dollars per bushel, f.o.b.	
Canada		
Manitoba No. 1	1.95	2.35
Manitoba No. 3	1.90	2.30
United States		
Dark northern spring No. 1	1.83	2.23
Hard red winter No. 2	1.73	2.13
Australia		
Fair average quality	1.68	2.08
Argentina		
Plate wheat	1.73	2.13

Source: U.S. Economic Research Service (1970, p. 71).

TABLE 38
CANADA, AUSTRALIA, AND ARGENTINA:
1980 PROJECTED QUANTITY AND VALUE OF WHEAT EXPORTS
PRODUCER PRICES ABOVE $1.50 PER BUSHEL

Table number	Exports: Canada		Australia		Argentina	
	1,000 bushels	*1,000 U.S. dollars*	*1,000 bushels*	*1,000 U.S. dollars*	*1,000 bushels*	*1,000 U.S. dollars*
22	834,605	1,452,213	350,165	609,287	237,580	470,408
24	793,440	1,459,930	368,610	678,242	254,450	531,800
25	749,820	1,139,726	413,990	629,265	268,135	418,291
29	1,006,105	2,173,187	423,335	914,404	271,680	597,696
33	801,145	1,321,889	335,885	554,210	223,455	424,564
Appendix Table 6	961,980	1,952,819	400,245	812,497	254,405	536,350

The Green Revolution

In the last half of the 1960's, new, potentially productive varieties of rice and wheat have been used by several less-developed Asian countries. In 1968–69 approximately 7 percent of the rice land and 16 percent of the wheat area in the less-developed countries of Asia, excluding Communist China were seeded with the new rice and wheat varieties (Willet, 1969, p. 5). Table 39 indicates, by country, the estimated number of hectares seeded in 1968–69 with the new varieties. As a comparison, in 1967–68 the hectares seeded with the new rice and wheat varieties amounted to 3 and 11 percent of the total, respectively, and in 1966–67 only 1 and 2 percent, respectively.

The yield advantage of the new rice and wheat varieties depends primarily on the adequate use of related inputs, such as fertilizer and irrigation. For example, when no fertilizer is used with the new varieties, these have little if any advantage over the traditional varieties. However, numerous experiments suggest that the new rice and wheat varieties have a yield advantage of 30–100 percent (when complemented with adequate irrigation and a high level of fertilization) compared to traditional varieties grown under similar conditions (Willett, 1969, p. 13).

At the time of this analysis, the above information on the use of new crop varieties in Asia was not available. As a result, production and consumption for Other Asia were projected on the basis of data from 1959 to 1966. During this period total wheat production showed a gradual decline, although consumption increased. Using these data, production for Other Asia was projected to be 1.3 billion bushels (table 17), which is below that for any of the years from 1959 to 1966. Consumption was projected at approximately 3 billion bushels (table 16), which is above the yearly figures for 1959–66. The resulting import gap is 1.7 billion bushels. In view of the recent introduction of new crop varieties in Asia, the projected import gap appears to be an upper estimate (Willett, 1969, p. 22). Assuming that

TABLE 39

WEST, SOUTH, AND SOUTHEAST ASIA: AREAS PLANTED TO ALL VARIETIES AND NEW VARIETIES OF RICE AND WHEAT, 1967-68 AND 1968-69

Major countries	Rice area*		Wheat area†	
	All varieties 1967-68	New varieties 1968-69	All varieties 1967-68	New varieties 1968-69
	million hectares			
Turkey	‡		8.1	.60
West Pakistan	1.4	.28	6.0	1.21
East Pakistan	9.9	.08	.1	.02
India	36.7	3.77	14.9	4.05
Burma	5.2	.22		
South Vietnam	2.3	.04		
Philippines	3.0	.45		
Indonesia	7.4	.38		
Total	65.9	5.22	29.1	5.88

*Total area (1968-69) for South and Southeast Asia = 77.3 million hectares.
†Total area (1968-69) for West and South Asia = 36.3 million hectares.
‡Blanks indicate areas planted are insignificant.
Source: Joseph W. Willett (1969, p. 11).

5.22 million hectares in Asia are currently planted to new wheat varieties (table 39) and that yields increase by 50 percent (an 18.35 bushel per hectare increase) over the traditional varieties planted, and assuming that although the past rate of adoption of the new varieties is greater than 2 million hectares per year, only 1 million hectares are seeded with the new varieties, the result will be a yearly production increase of approximately 310 million bushels. This amount, added to the above projection of 1.3 billion bushels, gives a total production of 1.6 billion bushels for Other Asia or a reduction in the import gap from 1.7 billion to 1.4 billion bushels. In the equilibrium solution various import gaps were assumed for Other Asia. These ranged from a high of 1.7 billion to a low of 1.2 billion bushels.

The projected demand from which the imports were calculated was 3 billion bushels. How reasonable this projection is depends on, among other things, rice production increases in Asian countries and the degree to which rice will replace wheat as a major food item. It is observed in table 39 that rice acreage in the Asian countries for 1968–69 was 77.3 million hectares, which was more than twice the hectares in wheat. Also, rice yields were 1.6 metric tons per hectare before the introduction of the new varieties as compared with 1 metric ton for wheat. Assume that by 1980 rice yields in Asia, because of new varieties, increase 50 percent and assume that 2 million hectares are seeded with the new varieties in addition to the 1968–69 amount of 5.22 million hectares; based on these assumptions, production will be approximately 800 million bushels above that calculated using 77.3 million hectares and a yield of 1.6 metric tons per hectare. Therefore, if part of this increase substitutes for wheat consumption, the projected wheat demand of 3 billion bushels is likely biased upward. Thus, due to the production potential of both the new wheat and rice varieties, the import gap for Other Asia of 1.2 billion rather than 1.7 billion bushels could well be more realistic, giving an additional reason why the the projected exports in table 38 are likely not to be realized.

Communist China and the U.S.S.R.

In discussing productivity changes, reference must also be made to Communist China and the U.S.S.R. (the Asian countries listed in table 39 do not include Communist China). It became apparent in the 1960's that Communist countries can greatly affect world wheat prices and trade. Based on data from 1959–60 to 1963–64, the above two Communist countries combined seeded more acreage to wheat than the United States, Canada, France, India, Turkey, Italy, Australia, and Argentina combined. The U.S.S.R. seeded 157.4 million acres and Communist China seeded 61.9 million acres. However, wheat yields in these areas are considerably below those in many large world wheat-producing regions. The average yield for the U.S.S.R. during the period mentioned was approximately 14 bushels per acre, while for Communist China it was approximately 12 bushels per acre.

To what extent yields will increase in the future in these countries will depend largely on the emphasis given by the central plan authorities to developing their agricultural sectors. However, if even small increases in yields occur, it is rather startling to speculate the consequences. Suppose that, due to technological improvements, yields increase in both the U.S.S.R. and Communist China by 3 bushels per acre above those calculated in the 1980 projections. The combined increase in production, based on 61.9 million and 157.4 million acres for Communist China and the U.S.S.R., respectively, would be 657.9 million bushels. As the solutions indicate, the wheat economy cannot absorb a production increase of this size unless a substantial reduction in wheat exports occurs.

Increased Wheat Yields and the EEC

For Japan, the United Kingdom, France, Italy, West Germany, Belgium-Luxembourg, and the Netherlands, both low and high yield projections were used (table 11). In view of recent yield increases in these countries, our low estimates appear to understate their yield potential. The projected prices based on high yield projections are, in every instance, below those negotiated under the Cereals Agreement. Also, as pointed out, producer prices in the large exporting countries decreased by approximately 20 cents per bushel when the high yield projections were used. Due to the price decrease, combined exports from the United States, Canada, Australia, and Argentina declined by approximately 170 million bushels—a 10 percent decrease in total exports. The total loss in producer revenue from both this loss in exports and the decrease in domestic miller prices approaches $250 million—a 10 percent decline in producer receipts from those obtained assuming low wheat yields.[37]

When the high yield projections were used the EEC countries as a whole are predicted to be self-sufficient in the absence of the common external tariff (table

[37] These calculations are based on a comparison of tables 21 and 24.

33).[88] For the two large wheat producers in the EEC—France and Italy—it should be noted that the projected wheat yields, labeled in this study as high, are 51.81 and 47.78 bushels per acre, respectively. Yet, the actual yields in 1964 were over 45 bushels per acre. Therefore, it is not impossible for yields to be above those used in the analysis, and, even in the absence of external tariffs, the EEC countries as a group could well be net wheat exporters.

It is unlikely, however, that the EEC will abandon its protectionist policy against wheat exporters. As a result, the greatest part of our analysis incorporated an EEC target price of $2.90 or $3.30 per bushel. Except for the amounts of wheat which are likely to be imported to blend with the soft wheats grown locally, the results indicate that the EEC will be a wheat exporter. This appears to be the case even when the target price of $2.90 per bushel and low wheat yields are assumed. However, the EEC is predicted to be a rather sizable exporter when the high yield projections are used in the analysis. Therefore, unless drastic changes occur in the world wheat economy, the authors feel that the traditional large wheat exporters in the last part of the next decade will no longer find markets in the EEC, thus depressing world prices.

The Large Exporting Regions

A rather dismal future is predicted for the wheat economies in the large exporting regions, such as Australia, Argentina, Canada, and the United States. The reasons for this become apparent when wheat is viewed as merely one commodity in a complex basket of internationally traded goods. Thus, the extent to which wheat is traded depends on the degree to which other goods are also traded.

Consider the less-developed countries where the potential demand for wheat appears to be the greatest. Many of these countries do not have the foreign currencies available to pay for wheat imports for two reasons: first, many less-developed countries have only a few commodities, many of which are agricultural, to export for hard currencies; second, the majority of export earnings available are used for imports of industrial rather than agricultural products. Thus, unless those countries can significantly increase exports to high-income countries to procure foreign exchange earnings, it is unlikely that the food shortages which appear to exist in many of the countries will be met by wheat imports.

Closely related to the above situation is the international transfer of technology in developing new high-yielding rice and wheat varieties in less-developed regions of the world. The potential increases in supply due to this transfer, coupled with the emphasis on self-sufficiency in agriculture by many of the less-developed countries, add support to the belief of the authors that the future cereal needs of these countries will come largely from local production.

A point which is often overlooked is the extent to which income is redistributed when governments interfere with the free international movement of both agricultural and nonagricultural trade. In their paper on real wages and the costs of protection, Stolper and Samuelson (1950) demonstrated that in a two-commodity model the industry possessing the comparative advantage suffers a loss in a real income if the import industry is protected from foreign competition—that is, the

[88] This excludes any imports of high protein wheats used to mix with the low protein wheats now produced in the EEC countries. If these are sizable, the results suggest that these countries, taken together, would both import and export wheat in the absence of a common external tariff.

imposition of a tariff results in a redistribution of income in favor of the protected industry. It is probable that the wheat economies in large exporting countries have suffered substantial losses in real income due to the tariff protection afforded other industries in those countries which cannot compete internationally—examples are the EEC tariffs and protectionist policies used by the less-developed countries. Although it is difficult to determine cause and effect, these seem to have adverse effects on wheat exporting sectors which many contend have a natural comparative advantage. Since a world of free trade in all commodities is unlikely, the possibility of a buoyant market for wheat exports resulting therefrom is eliminated.

Historically, in an attempt to keep wheat prices above the minimum negotiated in past international wheat agreements, four major policies have been used by exporters to restrict the quantity of wheat placed on international markets. The specific reference is to the United States and Canada—the two largest wheat exporters. Three policies used by the United States are acreage controls, Commodity Credit Corporation wheat storage programs, and wheat exports for soft currencies under P. L. 480. The policy used by the Canadian Wheat Board allocates delivery quotas to individual farmers on the basis of the number of cultivated acres on each farm unit.

Wheat acreage allotments and soft currency sales were incorporated in the equilibrium solutions. Why the latter was included may not be immediately apparent. In the spatial equilibrium framework, the demand curves are effective demands in that they represent quantities which can be purchased with United States dollars, the common unit of measurement. Sales abroad by the United States for soft currencies do represent an effective demand in that the United States government pays United States producers dollars for these quantities.[39] Therefore, the amount of sales for soft curriencies can be added to the total effective demand of world importers. However, if these shipments are discontinued, an effective demand component of the model is eliminated since the United States government no longer buys wheat from the producer for these purposes. Therefore, at given prices, effective demand decreases. As demonstrated earlier, in order for the commercial market to absorb the quantities no longer shipped under P. L. 480, wheat prices must decline.

In deriving the solutions, it was pointed out that wheat stocks were not allowed to vary since the concept of a normal year was employed. Therefore, no analysis was conducted on how changing levels of stocks affect world wheat prices and exports. This is not to say that stocks are not crucial in forecasting the future of the wheat economy.[40] As an illustration, consider the equilibrium solutions which contain projected prices below the minimum established by the Cereals Agreement. By imposing various demand levels for stocks so that amounts of wheat are allowed to accumulate in the large wheat exporting countries, prices could be in-

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[39] The size of United States wheat shipments under P. L. 480 is substantial. For example, in the 1965–66 market year, two-thirds of the 867 million bushels of wheat exported by the United States was to meet its food aid program requirements. Over 70 percent of the food program exports were sales for foreign currency.

[40] In the past, considerable quantities of wheat have been stored in farm, commercial, and government storage facilities to prevent wheat prices from drastically declining. As indicated, the United States wheat stocks were at a record high of 1.40 billion bushels beginning the 1961–62 crop year, while Canada reached a record 720 million bushels beginning the 1957–58 crop year.

creased such that they would fall within the negotiated price range. However, by so doing, export quantities are reduced, which then leaves the crucial question as to whether the total revenue of export sales in increased. Obviously, it also presents the problem of how to dispose of the accumulated stocks.

In view of the above, it is not realistic to merely present "the solution" with corresponding projected prices and exports unless, among other things, future government policies are known. If these are predetermined, it is then merely of academic interest to determine the impact of alternative policy actions. Since future policies are not known, it is necessary to provide a range of projections corresponding to a range of policy actions. A comparison of any two solutions is important in an evaluation of the isolated effects of a specific change in policy. However, one must look at all of the solutions together to draw general conclusions about the future world wheat economy.

Appendix A, Table 1
WHEAT TRANSPORTATION COST MATRIX, PORT TO PORT*

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						U.S. cents per bushel, 1965 rates					
United States	0	†	26.11	21.42	28.12	24.14	15.29	33.48	34.82	32.81	21.42
Canada		0	26.11	22.76	22.26	20.93	12.60	24.10	32.81	26.11	22.76
Australia			0	24.91	21.56	31.16	29.07	16.50	7.75	11.25	21.42
Argentina				0	47.63	33.30	30.10	32.81	42.86	37.50	a
Japan					0	18.08	27.45	28.79	20.08	19.41	20.31
United Kingdom						0	8.03	14.73	32.81	24.10	28.12
EEC							0	14.06	28.79	22.09	23.43
Other Europe								0	18.75	21.42	31.47
Other Asia									0	24.10	42.18
Africa										0	38.83
Other America											0

*Based on an unpublished transportation study done under the direction of Professor John Moore, University of Maryland, for the North Central Marketing International Trade Project (NCM-33). The costs used by Moore are modified on the basis of data available from the following two sources. It is assumed that the above costs will remain in effect by 1980. Recent studies indicate that, due to improved ocean shipping, costs are not expected to increase greatly.

†No data available.

Sources: U.S. Economic Research Service (1967); International Wheat Council (1966).

Appendix B, Table 2

ESTIMATED PER CAPITA DEMAND EQUATIONS FOR WHEAT AS FOOD, BY COUNTRY[*]

Country	Equation number	Estimated demand equations† (per capita human consumption)	R^2	D.W.
United States	(1)	$\frac{Q_h}{L} = 4.38 - .0491P_m - .0008N$ $(.00006)^a \; (-.4453)$	.9495	0.71
Canada	(2)	$\frac{Q_h}{L} = 5.95 - 1.141P_m - .0002N - .0489T$ $(.4093)^a \; (.0019) \; (.0914)$	.7031	2.39
Australia	(3)	$\frac{Q_h}{L} = 7.93 - .6340P_m - .0030N$ $(.126)^a \; (.0008)^a$	.8191	1.68
Japan	(4)	$\frac{Q_h}{L} = 1.143 - .085P_m + .000004N - .030T$ $(.294) \; (.000002) \; (.024)$	.8605	2.23
United Kingdom	(5)	$\frac{Q_h}{L} = 6.804 - .501P_m - .0132N$ $(.364) \; (.0036)^a$	.7667	2.80
France	(6)	$\frac{Q_h}{L} = 6.380 - .056P_m - .0017N$ $(.220) \; (.0005)^a$	.6195	2.18
Italy‡	(7)	$\frac{Q_h}{L} = 5.255 + .307P_m - .0024N$ $(.460) \; (.0046)$	.4822	1.23
West Germany	(8)	$\frac{Q_h}{L} = 4.57 - .4002P_m - .001N$ $(.3422) \; (.0002)^a$	.8124	1.54
Netherlands	(9)	$\frac{Q_h}{L} = 5.470 - .7576P_m - .0004N$ $(.2176)^a \; (.0006)$	.8301	2.36

[*]For the results in Appendix Tables 2 and 3, the following notation is used:

Q_h = total consumption of all classes of wheat for food (millions of bushels)

L= population (millions)

P_m = weighted price paid by millers for all classes of wheat (United States dollars undeflated except for Argentina where the deflator used is the consumer price index, 1965 = 100)

N = a measure of per capita disposable income in United States dollars undeflated except for Argentina where the deflator used is the consumer price index 1965 = 100. (Note: disposable income statistics were available for only the U.S., Canada, and Japan. Income measures used for the other countries are: personal per capita consumption expenditures for Australia, France, West Germany, Belgium-Luxembourg, and the Netherlands; per capita GNP for Argentina; an index of consumption expenditures for the United Kingdom; and an index of real per capita private consumption expenditures for Italy.)

T = time in years

and

Q_d = total consumption of all classes of wheat for food, feed, seed, and industrial purposes.

All variables are specified for time t.

†The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the 1 per cent level of probability, "b" denotes significance at the 5 per cent level of probability, and "c" denotes significance at the 10 per cent level of probability.

‡A positive price coefficient results regardless of whether or not a trend variable is included.

APPENDIX B, TABLE 3

ESTIMATED PER CAPITA DEMAND EQUATIONS FOR ALL WHEAT USES, BY COUNTRY*

Country	Equation number	Estimated demand equations† (per capita demand for all wheat uses)	R^2	D.W.
United States	(10)	$\frac{Q_d}{L} = 2.762 - .2495P_m + .0016N - .1915T$ (.4400) (.0025) (.1407)	.8839	1.12
	(11)	$\frac{Q_d}{L} = 7.113 - .1244P_m - .0018N$ (.4395) (.0003)[a]	.8600	0.79
Canada	(12)	$\frac{Q_d}{L} = 22.01 - .4662P_m - .0099N + .1754T$ (1.818) (.0079) (.3312)[a]	.7724	3.00
	(13)	$\frac{Q_d}{L} = 18.24 - .7071P_m - .0058N$ (1.679) (.0014)[a]	.7633	3.05
Australia	(14)	$\frac{Q_d}{L} = 8.822 - 2.693P_m + .0041N - .0703T$ (1.392)[c] (.0071) (.0091)	.7630	2.67
	(15)	$\frac{Q_d}{L} = 12.283 - 3.325P_m - .0007N$ (1.039)[a] (.0049)	.7481	2.61
Argentina	(16)	$\frac{Q_d}{L} = 6.048 - .000001P_m - .0016N + .3309T$ (.000002) (.0003)[a] (.0885)[a]	.7689	2.31
	(17)	$\frac{Q_d}{L} = 7.198 - .000001P_m - .0005N$ (.000002) (.0003)	.3080	1.06
Japan	(18)	$\frac{Q_d}{L} = 5.465 - 2.783P_m + .00001N - .1095T$ (.9665)[b] (.000004)[a] (.0455)[b]	.9495	2.18
	(19)	$\frac{Q_d}{L} = 2.338 - .6460P_m + .000003N$ (.5132) (.0000006)[a]	.8911	1.40
United Kingdom	(20)	$\frac{Q_d}{L} = 7.339 - .0302P_m - .0154N - .0014T$ (1.848) (.0650) (1.881)	.3557	2.92
	(21)	$\frac{Q_d}{L} = 7.399 - .035P_m - .0158N$ (1.601) (.0106)	.3557	2.91
France	(22)	$\frac{Q_d}{L} = 16.57 - 1.018P_m - .0129N + .3789T$ (1.457) (.014) (.370)	.1582	3.36
	(23)	$\frac{Q_d}{L} = 7.468 - .6865P_m + .0013N$ (1.425) (.0034)	.0322	2.86
Italy	(24)	$\frac{Q_d}{L} = 7.143 - .0531P_m - .000019N - .0381T$ (.0819) (.0096) (.0426)	.7640	1.36
	(25)	$\frac{Q_d}{L} = 6.997 - .0621P_m - .000017N$ (.0253)[a] (.0002)	.7516	1.47
West Germany	(26)	$\frac{Q_d}{L} = 7.179 - .7878P_m - .0015N + .0035T$ (.8648) (.0023) (.0796)	.6110	2.22
	(27)	$\frac{Q_d}{L} = 7.167 - .7961P_m - .0014N$ (.7957) (.0005)[c]	.6109	2.23
Belgium-Luxembourg	(28)	$\frac{Q_d}{L} = 6.098 - .1526P_m - .0007N - .0247T$ (1.007) (.0014) (.0314)	.6058	2.56
	(29)	$\frac{Q_d}{L} = 7.330 - .3912P_m - .0016N$ (.9393) (.0008)[c]	.5753	2.18
Netherlands	(30)	$\frac{Q_d}{L} = 7.303 - .0628P_m - .0079N + .1917T$ (.7791) (.0057) (.1097)	.6986	1.72
	(31)	$\frac{Q_d}{L} = 1.635 + .9640P_m + .0016N$ (.6271) (.0018)	.5146	2.06

*See footnote Appendix table 2.

†The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the 1 per cent level of probability, "b" denotes significance at the 5 per cent level of probability, and "c" denotes significance at the 10 per cent level of probability.

APPENDIX C, TABLE 4
ESTIMATED WHEAT ACREAGE EQUATIONS BY COUNTRY*

Country	Equation number	Estimated acreage equations†	R^2	D.W.
Canada	(32)	$A = 6{,}611.61 + 12{,}825.81P_{f(t-1)} - .0194S - 500.94P_{y(t-1)} + 478.94T$ (3,682.51)[a] (.0088)[b] (609.84) (143.41)[a]	.786	1.401
	(33)	$A = 3{,}203.12 + 13{,}386.78P_{f(t-1)} - .0153S + 436.55T$ (3,576.35)[a] (.007)[c] (132.43)[a]	.775	1.618)
	(34)	$A = -2{,}028.28 + 8{,}572.06P_{f(t-1)} + .5287A_{(t-1)}$ (5,974.55) (3.295)	.688	.852
	(35)	$A = -1{,}972.13 + 8{,}656.67P_{f(t-1)} - 56.06P_{y(t-1)} + .5285A_{(t-1)}$ (6,383.02) (815.76) (.3455)	.688	.868
Australia	(36)	$A = 4{,}812.10 + 6{,}352.94P_{f(t-1)} - 42.52P_{w(t-1)}$ (5,111.70) (26.24)	.260	.585
	(37)	$A = 1{,}455.41 + 6{,}756.43P_{f(t-1)} - 25.60P_{w(t-1)} + 221.91T$ (4,841.21) (27.31) (147.21)	.397	.541
	(38)	$A = 1{,}811.56 = 3{,}114.04P_{f(t-1)} - 73.53P_{w(t-1)} + .8874A_{(t-1)}$ (4,682.35) (.052)[a] (.306)[b]	.839	1.700
Argentina	(39)	$A = 6{,}562.18 + 11{,}974.57P_{f(t-1)} - 78.09P_{b(t-1)} + 255.65T$ (11,394.94) (292.04) (265.21)	.221	2.056
	(40)	$A = -2{,}405.12 + 22{,}576.58P_{f(t-1)} - 128.65P_{x(t-1)}\ 278.48T$ (9,279.03)[c] (49.74)[c] (270.41)	.550	2.882
Japan	(41)	$A = 2{,}407.34 + 119.77P_{f(t-1)} - 10.70I_w + 20.04T$ (310.23) (12.08) (54.44)	.629	1.195
	(42)	$\frac{A}{L} = .3844 + .0192P_{f(t-1)} - .0016I_w + .0025T$ (.0501) (.0019) (.0088)	.642	1.189
United Kingdom	(43)	$A = 2{,}391.01 + 1{,}292.84P_{f(t-1)} - 172.07P_{x(t-1)} - 123.85P_{b(t-1)} + 61.82T$ (755.14) (64.74)[c] (65.59)[c] (31.99)	.554	2.627
	(44)	$\frac{A}{L} = .412 + .0446P_{f(t-1)} - .0161P_{x(t-1)} - .0114P_{b(t-1)}$ (.1001) (.0104) (.0103)	.553	2.632
France	(45)	$A = 10{,}980.82 + 492.98P_{f(t-1)} - 8.52R - 435.17W$ (316.48) (6.04) (77.51)[a]	.751	1.594
	(46)	$A = 10{,}647.18 + 1{,}187.03P_{f(t-1)} - 8.13R - 477.88W - 95.98T$ (604.65) (5.86) (75.73)[a] (72.06)	.786	1.945
	(47)	$A = 4{,}927.28 + 284.53P_{f(t-1)} - 2.86P_{x(t-1)} + .528A_{(t-1)}$ (476.09) (3.36) (.305)	.464	2.077

Continued

APPENDIX C, TABLE 4—*Continued*

Country	Equation number	Estimated acreage equations†	R^2	D.W.
Italy	(48)	$A = 10{,}543.99 + \underset{(502.77)}{561.75}P_{f(t-1)} - \underset{(32.33)}{11.975}P_{b(t-1)}$	.212	.7896
	(49)	$\frac{A}{L} = .4744 + \underset{(.0269)^c}{.0541}P_{f(t-1)} - \underset{(.0021)}{.00003}P_{b(t-1)} + \underset{(.0019)}{.001}T$	.290	1.199
	(50)	$A = 3{,}382.38 + \underset{(394.86)}{82.89}P_{f(t-1)} - \underset{(27.41)}{17.84}P_{b(t-1)} + \underset{(.2663)^b}{.7652}A_{(t-1)}$	.596	2.116
West Germany	(51)	$A = 2{,}088.12 + \underset{(128.23)}{171.17}P_{f(t-1)} + \underset{(9.56)^a}{63.16}T$	.892	1.442
Belgium-Luxembourg	(52)	$A = 907.91 + \underset{(97.64)}{157.51}P_{f(t-1)} - \underset{(2.97)}{1.06}P_{b(t-1)} - \underset{(.2147)}{.7290}L$	.761	1.042
	(53)	$\frac{A}{L} = .4799 + \underset{(.1187)}{.063}P_{f(t-1)} - \underset{(.0037)}{.005}P_{b(t-1)} + \underset{(.0029)^a}{.0148}T$	.846	1.884
Netherlands	(54)	$A = 83.59 + \underset{(50.51)^a}{191.98}P_{f(t-1)} - \underset{(.4971)}{.214}L$	.811	2.590
	(55)	$\frac{A}{L} = -.1198 + \underset{(.109)}{.127}P_{f(t-1)} - \underset{(.002)}{.0018}P_{b(t-1)} + \underset{(.006)}{.0035}T$	.847	2.017

*For the results in Appendix Table 4, the following notation is used:

A = acreage seeded (1,000 acres)
P_f = farm price of wheat (dollars per bushel)
P_y = farm price of flax (dollars per bushel)
S = stocks of wheat on farms at seeding (1,000 bushels)
M = moisture prior to seeding (6-month average—inches)
P_w = farm price of wool (dollars per ton)
P_b = farm price of beef (dollars per 100 lbs.)
P_x = farm price of barley (dollars per bushel)
I_w = index of hourly industrial wage rates (1950 = 100)
L = amount of arable land (1,000 acres)
R = aridity index
W = winter-effect index

and

T = trend

†The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the 1 per cent level of probability, "b" denotes significance at the 5 per cent level of probability, and "c" denotes significance at the 10 per cent level of probability.

APPENDIX D, TABLE 5

INCOME ESTIMATIONS AND PROJECTIONS TO 1980, BY REGIONS

Region	Equations*	1980 projections	Time series	R^2	D.W.
United States†	N = 1,343.13 + 57.53T (1.77)	3,126	1950-1963	.99	0.42
Canada†	N = 781.49 + 46.57T (1.72)	2.365	1947-1963	.98	0.23
Australia‡	N = 795.95 + 9.78T (1.50)	1,089	1951-1962	.81	1.58
Argentina§	N = 449.40 + 229.75T (38.92) (in pesos: 1.79 pesos = $1.00)	2,055	1950-1961	.78	.37
Japan†	N = 43,436.97 = 13,294.58 (1,027.55) (in yen: 370 yen = $1.00)	1,052	1955-1963	.96	0.63
United Kingdom¶	N = 99.87 + 3.00T (.16)	181	1954-1963	.98	1.01
West Germany‡	N = 362.85 + 34.43T (2.30)	1,396	1951-1962	.96	1.81
Italy‖	N = 83.83 + 4.39 (.24)	215	1951-1962	.97	0.56
Belgium-Luxembourg‡	N = 701.61 + 20.11 (2.69)	1.305	1951-1962	.85	1.82
Netherlands‡	N = 388.36 + 18.64 (1.78)	947	1951-1962	.92	0.96
France‡	N = 770.50 + 6.50T (2.52)	966	1951-1962	.93	0.87

*All coefficients are significant at the 99 per cent probability level; figures in parentheses are standard errors.

†Per capita disposable income (U.S. dollars, 1965 exchange rates).

‡Personal per capita consumption expenditure (U.S. dollars, 1965 exchange rates).

§Per capita GNP, undeflated (U.S. dollars, 1965 exchange rates).

¶Consumption expenditure index.

‖Real per capita private consumption expenditure index.

Sources: Statistical Office of the United Nations, Department of Economic and Social Affairs (1954 through 1966b); J. W. Vigen (1965).

APPENDIX D, TABLE 6

POPULATION ESTIMATIONS AND PROJECTIONS TO 1980, BY REGIONS*

Region	Equations†	1980 projections	Time series	R^2	D.W.
	thousands				
United States	P = 154,878 + 3,000.01T (61.20)	241,878	1952-1964	.98	.48
Canada	P = 11,465.65 + 381.16T (6.29)	24,807	1946-1965	.99	.23
Australia	P = 7,561.99 + 203.01T (9.08)	14,261	1948-1963	.97	2.00
Argentina	P = 16,917.48 + 333.53T (17.59)	26,923	1951-1962	.97	2.50
Japan	P = 85,862.95 + 634.05T (101.56)	104,885	1951-1965	.75	.78
United Kingdom	P = 50,481.73 + 312.83T (20.62)	58,928	1954-1963	.97	.44
West Germany	P = 48,037.62 + 687.12T (42.48)	68,651	1951-1962	.96	.48
Italy	P = 46,772.58 + 284.78T (1.58)	55,316	1951-1962	.99	1.14
Belgium-Luxembourg	P = 8,888.79 + 56.82T (1.47)	10,594	1951-1962	.99	1.19
Netherlands	P = 10,069.71 + 141.11T (2.17)	14,303	1951-1962	.99	.44
France	P = 41,370.01 + 422.61T (.02)	54,030	1951-1962	.97	.65

*Population projections similar to those contained in Food and Agriculture Organization of the United Nations, *Agricultural Commodities—Projections for 1975 and 1985,* Vols. I and II (Rome, 1967).

†All coefficients are significant at the 99 per cent level of probability; figures in parentheses are standard errors.

Source: Statistical Office of the United Nations, Department of Economic and Social Affairs (1954 through 1966a).

APPENDIX D, TABLE 7
ARABLE LAND EQUATIONS AND PROJECTIONS TO 1980, BY REGION

Region	Equations[*]	1980 projections	Time series data	R^2	D.W.
	1,000 hectares				
Japan	$L = 6{,}178.21 - 8.93T$ (6.211)	5,901	1950-1964	.2410	0.76
United Kingdom	$L = 7{,}329.29 + 2.49T$ (1.301)	7,406	1950-1964	.2684	0.45
Italy	$L = 16{,}233.11 - 53.54T$ (19.443)[b]	14,573	1950-1964	.3871	1.25
Belgium-Luxembourg	$L = 1{,}062.32 - 9.33T$ (.9145)[a]	773	1950-1964	.8890	1.44
Netherlands	$L = 1{,}074.08 - 4.89T$ (.8798)[a]	922	1950-1964	.7040	0.74

[*]The standard error is in parentheses under each regression coefficient. The level of significance is indicated as follows: "a" denotes significance at the 1 per cent level of probability and "b" denotes significance at the 5 per cent level of probability.

Appendix E, Table 8

OTHER EUROPE, AVERAGE PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS
EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
	1,000 bushels										
United States	616,585								823,575		59,845
Canada		200,455			171,815	166,875		100,000	293,400		
Australia			97,100						43,940	262,490	
Argentina				153,725							195,565
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	500,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
	U.S. dollars per bushel										
Origin price*	1.66	1.48	1.48	1.73	1.80	1.88	2.90†	1.79	2.04	2.02	2.01
Destination price‡	1.79	1.70	1.81	1.89	1.94	1.96	2.90	1.88	2.23	2.16	2.09
	1,000 bushels										
Consumption§	616,585	200,455	97,100	153,725	221,815	266,875	951,290	5,000,000	2,967,120	585,095	534,270
Production¶	1,500,005‖	932,545	403,530	349,290	50,000	100,000	1,040,005	5,400,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

APPENDIX E, TABLE 9

OTHER EUROPE, LOW PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	610,050								889,955		
Canada		184,880			166,800	151,975		100,000	543,205		
Australia			92,120						137,755	262,490	
Argentina				153,725							255,405
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	100,005		
Other Asia									1,306,200		
Africa										233,895	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	2.21	2.03	2.03	2.10	2.35	2.43	2.90†	2.34	2.59	2.57	2.38
Destination price‡	2.33	2.25	2.36	2.26	2.49	2.51	2.90	2.43	2.78	2.71	2.46
						1,000 bushels					
Consumption§	610,050	184,880	92,120	153,725	216,800	251,975	951,290	5,000,000	2,967,120	585,100	534,270
Production¶	1,500,005‖	1,146,860	492,365	409,130	50,000	100,000	1,040,005	5,000,005	1,306,200	233,895	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Appendix E, Table 10

OTHER ASIA, AVERAGE CONSUMPTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
	1,000 bushels										
United States	618,110								801,340		80,550
Canada		204,090			172,985	170,350		100,000	237,505		
Australia			98,260						22,080	262,495	
Argentina				153,725							174,855
Japan					50,000						
United Kingdom						100,000					
EEC							951,290			88,715	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
	U.S. dollars per bushel										
Origin Price*	1.53	1.35	1.35	1.60	1.68	1.75	2.90†	1.67	1.91	1.89	1.88
Destination price‡	1.66	1.57	1.68	1.76	1.81	1.83	2.90	1.75	2.10	2.03	1.96
	1,000 bushels										
Consumption§	618,110	204,090	98,260	153,725	222,985	270,350	951,290	5,000,000	2,667,120	585,100	534,270
Production¶	1,500,000‖	884,930	382,825	328,580	50,000	100,000	1,040,005	5,200,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Appendix E, Table 11

OTHER EUROPE, AVERAGE PRODUCTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $2.90 PER BUSHEL; UNITED STATES PRODUCTION, 1.8 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	622,560								1,036,400		141,040
Canada		213,530			276,030	71,515		100,000	100,000		
Australia			101,650						24,515	196,170	
Argentina				153,730							114,365
Japan					50,000						
United Kingdom						100,000					
EEC						107,870	951,290			155,035	
Other Europe								4,900,000	500,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.16	1.02	.98	1.22	1.34	1.42	2.90†	1.29	1.54	1.51	1.50
Destination price‡	1.28	1.24	1.31	1.39	1.48	1.50	2.90	1.38	1.72	1.66	1.59
						1,000 bushels					
Consumption§	622,560	213,530	101,650	153,730	326,030	279,385	951,290	5,000,000	2,967,120	585,095	534,270
Production¶	1,800,000‖	761,075	322,335	268,095	50,000	100,000	1,214,195	5,400,005	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Appendix E, Table 12

LOW WHEAT YIELDS; OTHER ASIA, AVERAGE CONSUMPTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $3.30 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From \ To	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	619,105								786,825		94,075
Canada		206,450			173,750	172,615		100,000	201,015		
Australia			99,015						73,075	197,210	
Argentina				153,725							161,335
Japan					50,000						
United Kingdom						100,000					
EEC							932,135			154,000	
Other Europe								4,900,000	300,005		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin price*	1.45	1.27	1.27	1.51	1.59	1.67	3.30†	1.58	1.83	1.80	1.79
Destination price‡	1.58	1.49	1.60	1.68	1.73	1.75	3.30	1.67	2.02	1.95	1.88
						1,000 bushels					
Consumption§	619,015	206,450	99,015	153,725	223,750	272,615	932,135	5,000,000	2,667,120	585,100	534,270
Production¶	1,500,000‖	853,830	369,300	315,060	50,000	100,000	1,086,135	5,200,000	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

Appendix E, Table 13

HIGH WHEAT YIELDS; OTHER ASIA, AVERAGE CONSUMPTION: 1980 WHEAT PRICE, CONSUMPTION, PRODUCTION, AND TRADE-FLOW PROJECTIONS EEC TARGET PRICE, $3.30 PER BUSHEL; UNITED STATES PRODUCTION, 1.5 BILLION BUSHELS

From / *To*	United States	Canada	Australia	Argentina	Japan	United Kingdom	EEC	Other Europe	Other Asia	Africa	Other America
						1,000 bushels					
United States	621,935								745,540		132,525
Canada		213,015			175,860	178,890		100,000	100,000		
Australia			101,165						215,375	14,305	
Argentina				153,725							122,880
Japan					50,000						
United Kingdom						100,000					
EEC							932,135			336,905	
Other Europe								4,900,000	300,030		
Other Asia									1,306,200		
Africa										233,890	
Other America											278,860
						U.S. dollars per bushel					
Origin Price*	1.21	1.04	1.03	1.28	1.36	1.43	3.30†	1.34	1.59	1.57	1.56
Destination price‡	1.34	1.25	1.36	1.44	1.50	1.51	3.30	1.43	1.78	1.71	1.64
						1,000 bushels					
Consumption§	621,935	213,015	101,165	153,725	225,860	278,890	932,135	5,000,000	2,667,145	585,100	534,270
Production¶	1,500,000‖	767,765	338,845	276,605	50,000	100,000	1,269,040	5,200,030	1,306,200	233,890	278,860

*Price paid to producers at production center.
†Target price.
‡Price paid by millers at consumption center.
§Used interchangeably with "demand."
¶Used interchangeably with "supply."
‖Fixed because of acreage controls.

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