IMPACT OF PROJECTED WORLD WHEAT PRODUCTION-CONSUMPTION BALANCES ON U.S. EXPORTS AND PRICES

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Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1980

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ACKNOWLEDGMENTS

I am deeply indebted to a number of people without whom this study could not have been completed. It has been a pleasure for me to work with my adviser, Dr. Leo V. Blakley. His patience, clarity of thought, attention to detail and gentle guidance have made this study an extremely valuable and rewarding experience for me. I also wish to express my gratitude to my other committee members Dr. Gary M. Mennem, Dr. Paul D. Hummer, and Dr. Michael J. Applegate, for their assistance in the preparation of the final manuscript.

I greatly appreciate the financial support which was extended to me by Dr. James S. Plaxico and Dr. James E. Osborn who have served as heads of the Department of Agricultural Economics during my stay at Oklahoma State University. I am grateful for the statistical and secretarial staff support of the Agricultural Economics Department, particularly the assistance of Debbie Kukuk, Debbie Glazner, Judy Ivy, Jane McMurray, Karina Flynn and Vicki Melton in completing the initial draft of this study. The experience and skill of Sandi Ireland and Linda Howard have been extremely valuable in the completion of the final draft.

I owe a note of thanks to two of my close friends and colleagues, Charles Safley and Marlys Nelson. By consulting with Charles on his parallel feed grain study, I have been able to borrow techniques and share information that has significantly improved the quality of my own study. Marlys has greatly facilitated the completion of the final

details of this study by consenting to coordinate the submission of the final draft to the Graduate College in my absence.

I wish to acknowledge the steadying influence and unqualified love and support my parents, Mr. and Mrs. John B. Webb, have provided me throughout my life and education--especially in the last few months of this study. In recent years, the love and assistance of my wife's parents, Mr. and Mrs. Ho-Dian Hwang, have also made an important contribution to the environment in which I studied and did research.

Finally, I consider myself blessed to have Shwu-Eng as my wife and Jessica as my daughter. Since Jessica came into this world seven months ago, she has been a joy and an inspiration to me--asking little and cheerfully accepting the limited time and comforts I could provide for her. Shwu-Eng's immeasurable contribution to this study spans all facits of support from consultation on the theoretical and econometric aspects of the models to financial assistance and encouragement throughout my years in graduate school. Without Shwu-Eng's love and support, this study never would have been attempted. To Shwu-Eng and Jessica I dedicate this dissertation.

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CHAPTER I

INTRODUCTION

In the months of July and August of 1972, the United States exported a total of 9.5 million metric tons of wheat to the Soviet Union--an amount greater than the total United States commercial exports in the previous crop year. The Russian purchase coupled with a sharp cutback in Peruvian fish mean production and food and feedgrain crop failures in other parts of the world led to an unexpected increase in the demand for U. S. wheat. In the space of one year's time, world grain markets were transformed from a condition of large surplus stocks and relatively low prices into a situation in which there were short supplies, burgeoning demand and rising prices.

Though wheat prices have since returned to lower levels, the experience of 1972 and 1973 has not been lost on the suppliers and users of American wheat. News of a Russian crop failure can still send prices soaring on futures markets where it is recognized that relatively small changes in world supplies can result in wide variations in prices.

The Problem

The year 1972 represents what appears to be a key juncture in the posture of United States grain trade. Prior to 1972, a large proportion of U. S. wheat exports were on a non-commercial basis to developing countries. Following the concurrent devaluation of the dollar and the

Russian grain purchase, there was a large increase in both commercial and total American wheat exports. Though prices have varied widely in the subsequent time period, the increase in total exports has been sustained while exports on a non-commercial basis have dwindled to a very small amount.

In light of these developments, the direction of future trends in world wheat supplies and demands has become of the utmost importance to the United States wheat economy. Are the events since 1972 to be interpreted as the result of a fundamental change in the economic environment in which world wheat trade is conducted or are these events to be viewed simply as a series of aberrations in what would otherwise have been a "normal" world wheat market? The response to this question will have a significant effect on the future United States' policy towards wheat production, levels of inventories and world wheat commerce. A "fundamental change", for example, might imply the need for a constant level of wheat stocks and an aggressive marketing policy vis-a-vis the other major wheat exporters whereas a "series of aberrations" would probably call for policies which allowed for wide variations in inventories.

A detailed analysis of key importing and exporting countries and regions along with a forecast of their future imports and exports will not only provide a projection of future trade levels, it will also help to answer the question posed above by putting the events of the past few years into the perspective of long run trends in wheat production and consumption. In this way this analysis will prove to be a valuable guide for determining the direction of future U. S. agricultural policy.

Objectives

The purpose of this study will be to analyze the supply and demand relationships in the world wheat market and develop models to forecast the future prices of American wheat. Specifically, this study will:

1) Identify market information which will be useful in determining the nature of the price discovery process for wheat. The information examined will include:
   a) a review of analytical and predictive models of wheat;
   b) the collection of data on wheat inventories, exports, imports, area harvested, yields, food used, feed use, and seed use for the United States and the major wheat importing and exporting countries of the world.
   c) an examination of government agricultural policies and institutions which would affect the price and flows of wheat between the U. S. and foreign markets.
2) Evaluate and construct models which will use the information obtained under objective 1 to project consumption, production, and prices for the American wheat economy.
3) Measure the impact of variations in export demand on the United States wheat economy and determine the response over time to these variations.

Organization of the Study

The remainder of this study will be divided into six chapters. Chapter II will examine the theoretical underpinnings of international trade and discuss briefly some of the issues pertinent to the trade of

agricultural commodities. This will be followed by a review of balance sheet models of the U. S. wheat economy and models of world wheat commerce.

Chapter III will separate the world into major wheat importing and exporting countries and regions. Regression equations will be estimated to explain the changes in wheat supply and demand for each country or region. Key countries will be singled out for individual balance sheet analysis.

Chapter IV will use the results of Chapter III to project the 1985 levels of supply and demand for each of the countries and regions specified. The projections will then be aggregated for the world excluding the United States to determine the 1985 demand for American wheat exports. Changes in supplies in important countries will be posited to map out the possible levels of variation in demand for U. S. exports.

In Chapter V, a simultaneous equation model will be constructed to explain the interaction between the wheat sector of the United States and the rest of the world. The emphasis in this chapter will be on developing a forecast of a 1985 long run trade equilibrium using the projections from Chapter IV.

Chapter VI will be concerned with the impact of variations in world supplies on the 1985 world wheat economy in equilibrium. Price movements and adjustments in the quantities supplied and demanded will interact in bringing the system back into equilibrium.

The final chapter will review the important findings of the study and draw conclusions. The importance of the study will also be evaluated and related areas for future study will be suggested.

CHAPTER II

INTERNATIONAL TRADE THEORY AND MODELS RELATED TO WHEAT

This chapter will look at how the price system operates in theory and in fact on the world level. To do this, the chapter is divided into two parts. Part I will examine general world trade theory for both the single and the two good case to be followed by a discussion of some of the issues in international agricultural trade. Part II will focus on wheat models at both the domestic and international level with an emphasis on comparing their structures, methodologies and forecasts. It is hoped that the discussion to follow will provide a solid foundation for the analysis presented in succeeding chapters.

Part I: Trade Theory

The Single Good Case

The key to maximizing the well being of both producers and consumers lies in the marketing system. Bresler and King (1970) define a market as

> . . . an area or setting within which producers and consumers are in communication with one another, where supply and demand conditions operate and the title to goods is transfered. The actual movement of goods in space or time is usually but not necessarily involved. In this communication process, prices are established, and these prices move up and down in response to changes in the underlying supply and demand forces (p. 75).

On the world scale, the market for wheat should be envisaged as conglomeration of markets in countries and regions throughout the world. In isolation, the price in each of these markets would be set independently as a function of local supply and demand conditions, but as part of a hierarchy of markets, the price in every market is determined not only by that market's local conditions, but also by the supplies and demands of all the other markets of the world. This is best illustrated with a simple interregional trade model shown in Figure 1.

For Figure 1, it is necessary to make a few clarifying assumptions and definitions. First, assume that a particular good, say wheat, is exchanged between only two regions or countries--an importing region, M, and an exporting region, X. Second, let these regions be spatially separated and let there be a given non-zero transport cost for the shipment of wheat between regions. Finally, assume that any trade barrier is a given quantified constant which can be added to the transport cost differential.

The exporting region (X) of Figure 1, is characterized by a relatively large supply, low demand and a low equilibrium price of P_X, while the importing region (M) has a relatively large demand, low supply and a high equilibrium price of P_M. On the price scale, note that the prices of the exporting region have been moved up by amount t which represents the unit cost of interregional transfer (including the unit tariff charge, if there is one). The excess supply schedule is derived by taking the horizontal difference between supply and demand in the exporting region and excess demand is obtained from the horizontal difference between demand and supply in the importing region. The intersection of excess supply and excess demand establishes the interregional equilibrium price, $\bar{P}$.

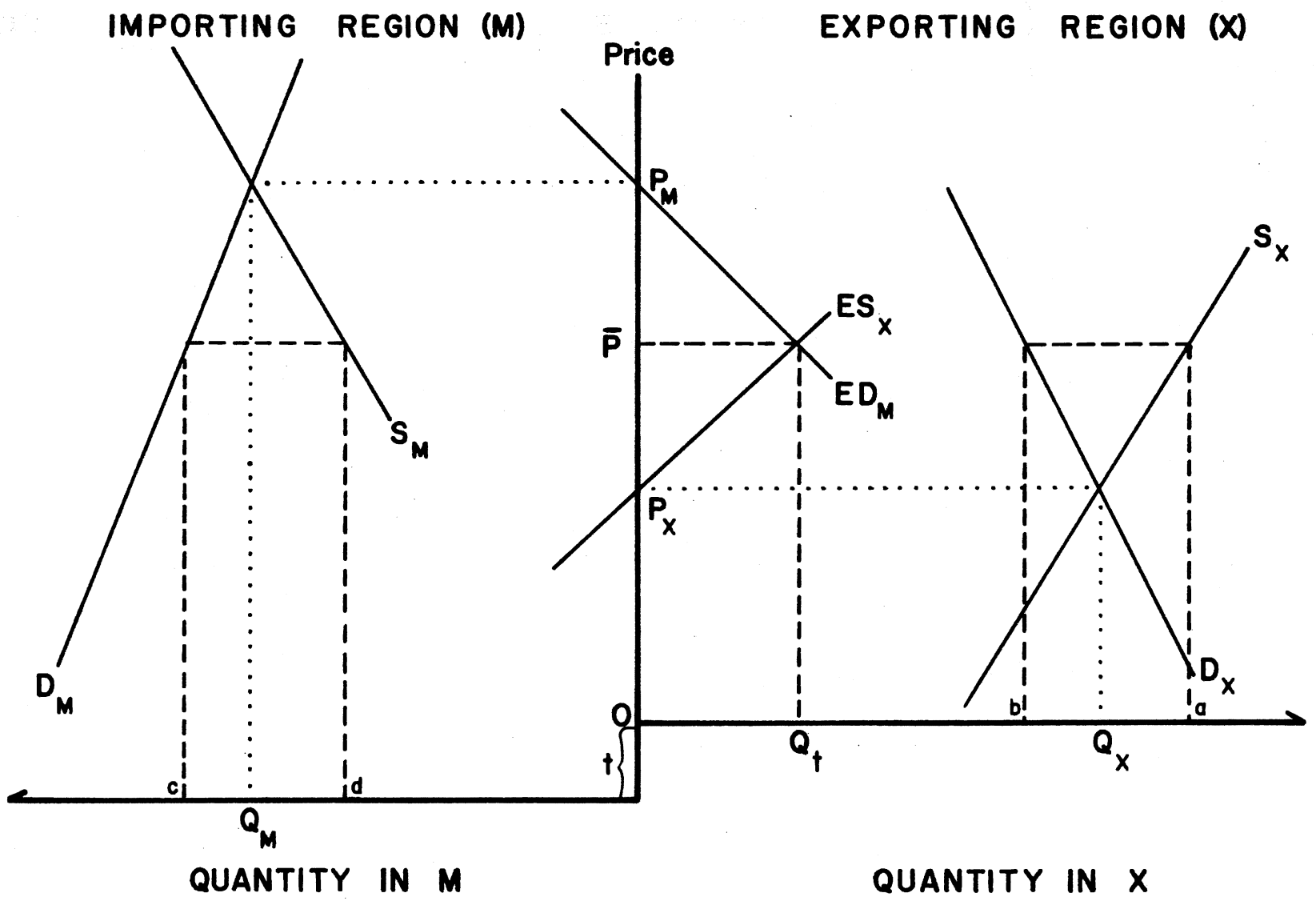

Figure 1. Trade of a Single Good between Two Regions

Figure 1 shows that, without trade, consumers in region M will have to pay a relatively high price, P_M, for their wheat. On the other have, region X can provide a sufficient amount of wheat to meet intra-regional needs at a much lower price, P_X. By allowing trade between the two regions, there arises the opportunity for arbitrage. Prices in the exporting region are bid up and prices in the importing region are bid down as traders transfer wheat between regions. When the inter-regional equilibrium price is attained at $\bar{P}$, the quantity transferred, OQ_t, will be equal to ab--the amount exported from region X--and this will equal cd--the amount imported by region M. Region X consumers will pay price $\bar{P}$ while in region M consumers will pay price $\bar{P}$ + t for wheat.

The Two Good Case

Though the interregional trade model in Figure 1 provides a concise analysis of the interaction between two regions for a single commodity, it fails to address three fundamental topics: 1) the basis for trade, 2) the direction of trade flows, and 3) the incentives to restrict trade. All of these questions address themselves to a broader dimension of trade. The first focuses on whether a region should concentrate resources and specialize in the production of a few exportable commodities and trade for the goods it doesn't produce or whether it should attempt to produce sufficient amounts of all commodities desired by its population. The second question is concerned with delineating a criterion for deciding what goods a country should specialize in producing. The last question will look at some of the welfare aspects of trade within an individual country, i.e., which groups gain and which groups lose because of trade.

The Basis for Trade. The answers to the first two question were developed over 150 years ago as part of the theory of comparative advantage. Though this concept was introduced by Adam Smith (1776, p. 4781), David Ricardo was the first to develop the theory in depth. He began by assuming the two country two good model shown in Table I.

TABLE I

DAVID RICARDO'S HYPOTHETICAL COMPARISON OF LABOR PRODUCTION COSTS IN PORTUGAL AND ENGLAND*

	Labor Cost of Production (in hours)	
	One unit of wine	One unit of cloth
Portugal	80	90
England	120	100

*Taken from Sodersten (1970), p. 16.

Note that Portugal has an absolute advantage over England in the production of both wine and cloth, but, of these, Portugal has a comparative advantage in wine. It can produce wine at 67% (80/120) of the labor cost in England while cloth can be produced as only 90% (90/100) of the English labor cost. Though England has an absolute disadvantage in both wine and cloth, it has a comparative advantage on cloth. The cost of English wine is 150% (120/80) of the cost of Portugese wine, but English cloth is only 111% (100/90) of the cost of Portugese cloth.

As long as the ratio of the cost of producing cloth in England to the cost of producing cloth in Portugal is different from the ratio of the cost of producing wine in England to the cost of producing wine in Portugal, both countries will have a comparative advantage in producing one of the two products and there will be an incentive to trade. If the ratio's are the same, the price of wine in terms of cloth will be the same in both countries and neither will have an incentive to specialize or trade.

Direction of Trade Flows and the Resulting Gains. The same single two country, two good example can also be used to determine the direction of the trade flow and the gains that will result from trade. Suppose that both England and Portugal are in a state of autarky--i.e., each of them consumes and produces in isolation. In England, then, the cost of a unit of wine will be 1.2 (120/100) units of cloth whereas the cost of that same unit of wine in Portugal will be only .89 (80/90) units in cloth. Without trade, wine will be more expensive than cloth in England and cheaper than cloth in Portugal.

Now assume that the two countries are permitted to trade. As long as the world price of a unit of wine in terms of cloth is between 1.2 and .89, both countries will find it advantageous to trade. If, for example, the world price of wine were 1.0 units of cloth, England could produce cloth and trade it for wine at a price that is .2 units below the price of internally produced wine. Portugal, likewise, could produce wine and exchange it for English cloth at a price that is .11 units of wine below the price (90/80) of internally produced cloth.

Although this simple model is based upon some rather restrictive assumptions--the labor theory of value, linear production functions, and a two good, two country world--the central conclusions will remain intact even if the assumptions are relaxed. A more complete discussion of the theory of comparative advantage can be found in Sodersten (1970) pp. 10-22 and 71-75.

The direction of trade flows and the gains from trade can also be shown graphically using the thinking of the more recent marginalist economists. In Figure 2, a production possibilities frontier, RTUS, is shown for the two good economy of Country A and represents the maximum level of production which can be attained with Country A's resources for different combinations of the two goods. The frontier is concave with respect to the origin indicating that successive increases in the production of one good, say wine, will require greater and greater sacrifices in the production of the other (cloth). On the same graph is a set of community indifference curves. They are a summation of the tastes and preferences with regard to wine and cloth of all the individuals in Country A. Since each curve represents a different constant level of utility, shifts of these curves up and to the right imply increases in the community's level of satisfaction. The convex curvature with respect to the origin of the indifference functions show that successive increases in the amount of one good consumed will result in diminishing satisfaction with each additional unit of that good.

The level of equilibrium of Country A under autarky is the point at which the production possibilities frontier is just tangent to the highest community indifference curve. In Figure 2, this equilibrium is

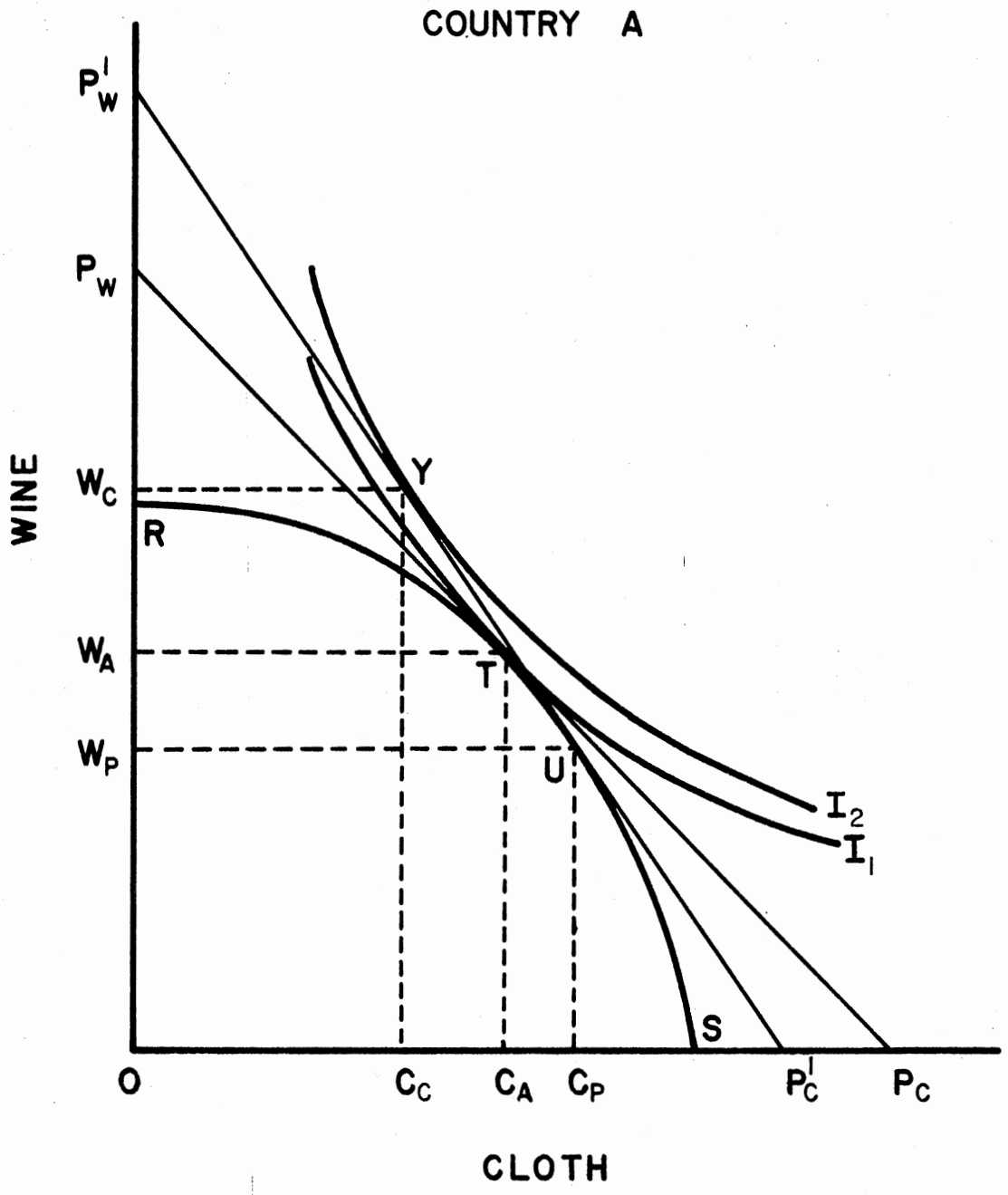

Figure 2. The Gains from Trade for a Single Country Producing and Consuming Two Goods

shown at point T. At this point, the rate at which wine can be substituted for cloth in production will be equal to rate at which the community is willing to substitute wine for cloth in consumption for a given level of utility. These rates of substitution in equilibrium will determine the price ratio of the two goods which is equal to OP_W/OP_C or the slope of the line tangent to point T. Since there is no trade, the quantities produced of wine and cloth--OW_A and OC_A, respectively--are equal to the quantities consumed.

Suppose Country A now has an opportunity to trade with other countries and further suppose that price ratio of wine to cloth on the world level is OP'_W/OP'_C--indicating a relatively higher price for cloth. At the new international prices, it will be to Country A's advantage to decrease its production of wine from OW_A to OW_P and increase its production of cloth from OC_A to OC_P. This new combination of wine and cloth at point Y is less preferred than the original combination at point T, but $C_C C_P$ units of cloth can be traded on the world market for $W_P W_C$ units of wine. Through specialization and trade Country A can reach a level of cloth and wine consumption (point U) that would have been unattainable under autarky. Other countries involved in the exchange will have different production possibility curves and different community indifference functions but they will benefit from trade in the same manner.

Incentives to Restrict Trade. There is one problem with the conclusion that because two countries benefit from trade that it is therefore desirable to trade. As brought out by Sodersten (1970),

> . . . the main point that Ricardo and the classical economists overlooked in their argument about the benefits of trade [was] one that has been raised by modern welfare economics . . . There is no guarantee that every consumer will be better off under free trade than under no trade, even though the country as a whole will be better off . . . (p. 39).

Approached from the viewpoint of welfare economics, the prevalence of tariffs, import quotas and other trade barriers can be interpreted as the logical outcome of attempts by certain interest groups to maintain or increase their incomes (and utility) by inhibiting competition from abroad. If the increase in the utility of these interest groups through the restriction of trade is greater than the decrease in utility for the rest of the society, the trade barrier is justified.

Issues in International Agricultural Trade

From the point of view of the major exporters of agricultural products, the most important trade issues center around policies and institutions which restrict trade. The most important policies are those which result in trade barriers such as tariffs, quotas, and other import restrictions. The most significant institutions are the economic customs unions (particularly the E.E.C.) and the international monetary system. Though neither of these institutions necessarily restricts agricultural trade, both have been major impediments to the expansion of American exports in the past decade.

Policies Which Restrict Trade. For agriculture, trade restrictions have long played an important role in world commerce. These restrictions have taken a number of forms. Traditionally, the most important form of trade restriction has been the tariff. The effect of a fixed tariff on a commodity, say wheat, is shown in Figure 3 in which Japan is purchasing ab tons from the United States at a price of OP_e. The United States' exporters receive a price of ZP_e for which they are willing to supply ef tons--an amount equal to the quantity (ab) that Japan desires to import.

Suppose Japan decides to impose a tariff of t dollars per ton on wheat imports. This will decrease the quantity demanded by Japanese consumers and increase the quantity supplied of wheat by Japanese producers. At the new higher price of OP_J $(=OP_{e+t})$, Japan will wish to decrease its imports from ab to cd. American exporters will have to accommodate their customer by decreasing exports by an equal amount from ef to gh. On the American side, this will bring about a decrease in price from ZP_e to ZP_{US}. Hence, the tariff has a dual effect--it increases the Japanese price of wheat by the amount of the tariff but the resulting decrease in Japanese excess demand causes a decrease in the U. S. price.[1]

The theoretical conclusions have been supported by empirical research. In a 1961 study, Mordechai Kreinen found that tariff reductions in 1955 resulted in a 59% increase in the volume of exports upon which the tariffs had been reduced as opposed to only a 17% increase in

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[1]For a more complete discussion of tariffs and international trade, see Heller (1973), pp. 163-182.

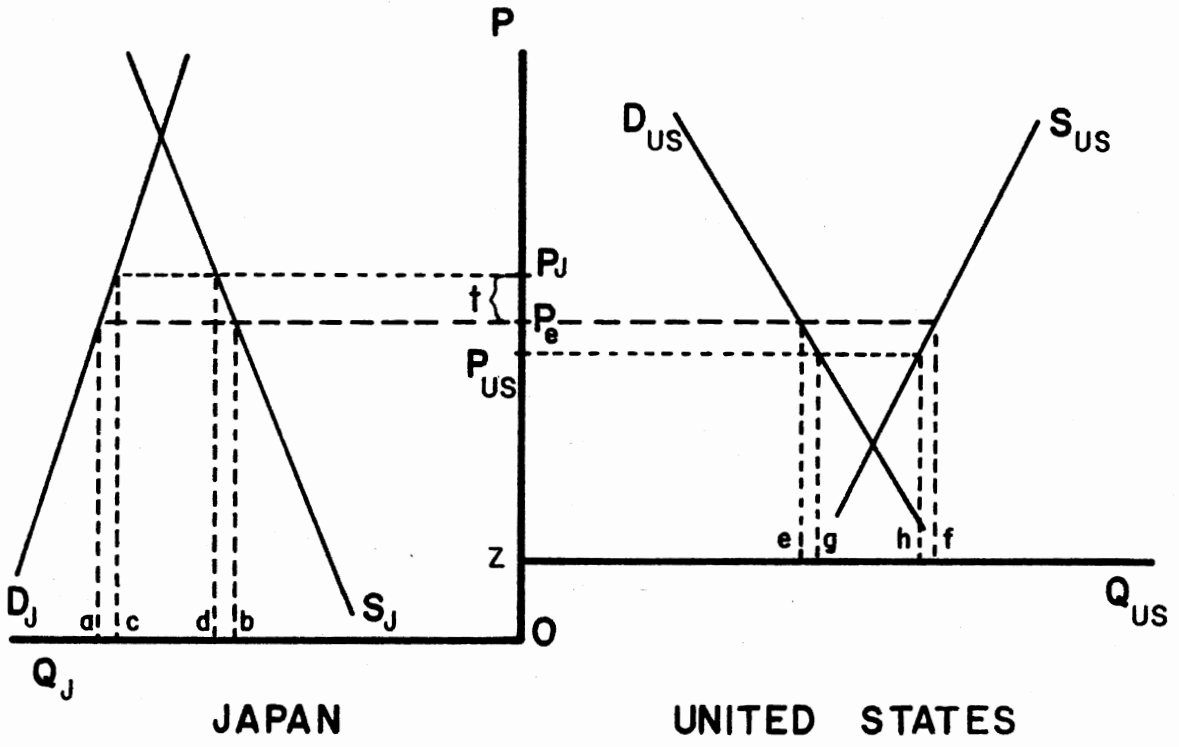

Figure 3. The Impact of a Tariff on Trade

imports for which the tariffs remained the same. In a later study, Belassa (1965) found that because of higher supply elasticities in the United States than in other industrial countries, imports would rise faster in America with the elimination of tariffs.

In the area of agriculture, Luttrell (1979, p. 3) maintains that "much of the increase in the proportion of farm products exported in recent years is a result of major changes in U. S. and other nations' foreign trade policies". In particular, he points to the reduction of trade barriers. He contends that U. S. imports and exports move in the same direction. Specifically, American farmers cannot expect to receive concessions from other countries without granting some trade concessions themselves.

Besides tariffs, there are a number of nontariff barriers--quotas, variable levies, quality standards, licenses, etc.--which can severely restrict trade. Hillman (1978, p. 6) has written a book on the subject of nontariff agricultural trade restrictions in which he contends that since World War I, "the world, particularly the industrial countries, [has] turned increasingly to nontariff barriers rather than to tariffs as protective measures for its internal agricultural programs" (p. 6). In part, he says, these nontariff barriers have emerged in response to the reduction of tariffs in the Kennedy Round negotiations as more and more countries "began searching for more oblique methods to protect domestic producers and traders" (p. 9).

One of the problems with nontariff barriers is that they often reduce the price responsiveness of markets even more than tariffs. As a result, in the 1972-74 period, "a 3.5% deviation from trend in world grain production caused considerable trouble in world markets" (Hillman,

p. 5). Similar conclusions were drawn by Shei and Thompson (1977) in an analysis of the influence of trade restrictions on the stability of world wheat prices. They conclude that, ". . . greater world market price variability results as more countries prevent world price signals from being reflected across their borders into the domestic market through some form of trade control . . ." (p. 637).

Institutions Which Have Restricted Trade. Many of the recent changes in tariff and nontariff barriers have come as a result of the creation of economic customs unions such as the European Economic Community (EEC), the Latin American Free Trade Association (LAFTA), the European Free Trade Association (EFTA) and the Central American Common Market (CACM). Palacio (1977) has shown that as a result of a set of common trade barriers for non-member countries, the member nations of each of these groups have stimulated as increase in trade among themselves at the expense of trade with nations outside their respective associations. Though these trade associations do reduce trade barriers for member nations, they often result in an increase and a broadening of trade restrictions to non-member countries as attempts are made by the association to accommodate the demands for protection from diversified interest groups in all of its member nations.

Nowhere are the policies of a trade association more successful than in the Common Agricultural Policy (CAP) of the EEC. The CAP is a comprehensive system of agricultural commodity price supports insulated from world market fluctuations by a complicated but extremely efficient set of variable levies. The effect of these levies is to keep the prices

of imported agricultural goods well above the prices of EEC produced goods irrespective of the level of actual world prices.

The CAP and particularly the system of variable levies has come under sharp criticism from major exporters of agricultural products such as the United States and Canada. The Europeans maintain that the CAP is simply a form of internal producer income maintenance and, as such, is not subject to trade liberalization negotiations. A couple of recent articles, however, show that the variable levy system goes far beyond producer income maintenance.

In a study of the effect of the CAP on European imports of meat, dairy products and eggs, Pagoulatos, Debertin and Pagoulatos (1978, p. 80) calculated that ". . . Extra-EEC imports under free trade conditions in 1972 would have been about 180 percent higher than actual for imports of meat, 70 percent for butter, 85 percent for cheese and 150 percent for eggs . . ." After studying the impact of tariff and nontariff barriers on Australian agricultural exports to the EEC, the same conclusions are echoed by Sampson and Yeats (1977). They found that ". . . the Common Agricultural Policy's potential for trade restriction, under levies and a variety of other protectionist measures, are indeed significant . . ." (p. 106). They go on to say that ". . . No inherent reason exists why these trade control measures should be treated differently within the context of the current multilateral trade negotiations from those measures applied in the nonagricultural sector . . ." (p. 106).

Although the reduction of trade barriers over the last 30 years has been important, the most significant recent development for U. S. agricultural trade has been the devaluation of the dollar in 1971 and the

conversion to a system of floating exchange rates in 1973. For much of the 1960's, U. S. agricultural exports suffered from an overvalued dollar. The costs of overvaluation are illustrated in Figure 4 taken from Shuh (1974). The supply and demand curves shown are for both domestic and foreign markets. Given an exchange rate in equilibrium, the level of international demand will be at a level of I_D and the industry will have an excess supply of Q_1Q_2 which it will export at a price of P_1. Now, suppose that over time under a system of fixed exchange rates the currency has become overvalued. To foreign purchasers, this will be viewed as a price increase causing a fall in international demand from I_D to I_D'. At this lower level of foreign demand, the industry will export less (Q_3Q_4) at a lower price (P_2). The magnitude by which the value of exports is reduced is shown by the shaded area in Figure 4.

The effect of the change to flexible exchange rates, as Schuh (1974) points out,

> . . . that an important basis of massive disequilibrium in world agriculture . . . has been eliminated. Resources in U. S. agriculture will be more nearly valued at their world opportunity cost levels, and the U. S. will be closer to realizing its true comparative advantage and capitalizing from a trade standpoint, on the sizeable investments in science and technology that it has made in the past . . . (p. 11)

The sharp increase in U. S. wheat exports in 1972 was in part due to decrease in the value of the dollar. To be sure, the Russian wheat purchase was also important, but even as the world wheat market has begun to return to a more stable level of prices, American wheat exports have remained above their pre-1972 levels. This seems to reflect a change more permanent than a short fall in the Russian crop, particularly since the other major exporters have not shown any such dramatic increase.

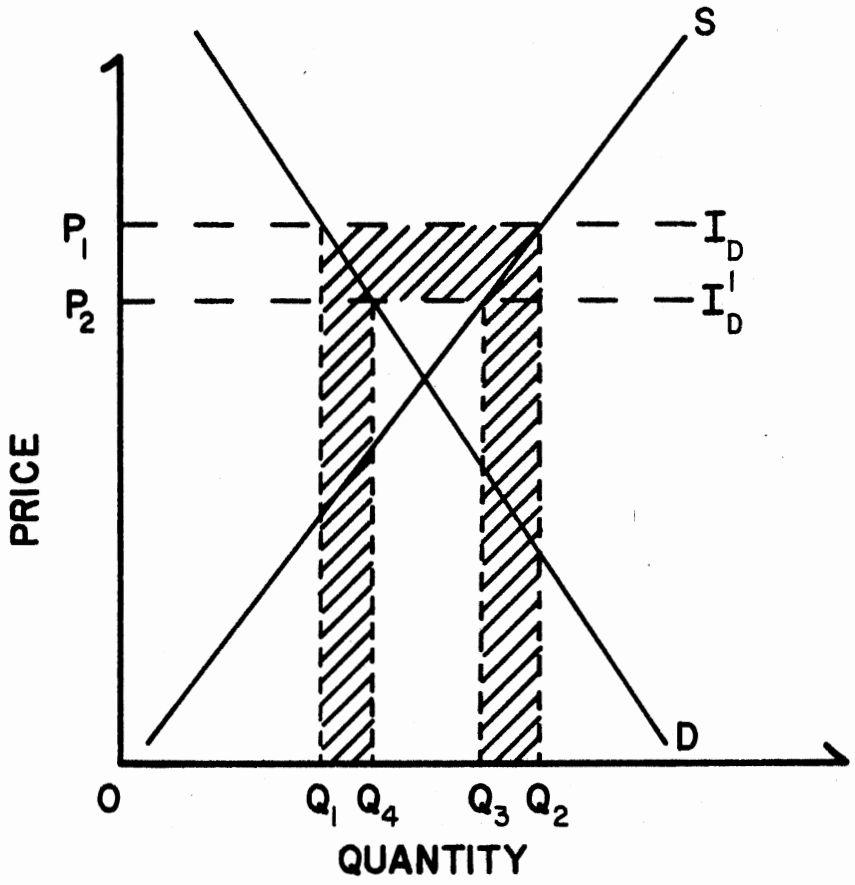

Figure 4. The Effect of an Overvalued Exchange Rate on Exports

Clearly, tariffs, nontariff barriers, and economic customs unions and exchange rates play an important role in determining the direction and magnitude of world agricultural trade. The specific nature of these policies and their impact on world wheat demand and supply will be discussed in relation to the analysis of individual countries in the following chapters.

Part II: Wheat Models

In the first part of this chapter, the economic theory relating to international trade was developed and discussed. In contrast, this section will concentrate on: 1) the methods used to estimate the structural relationships of the wheat economy of an individual country and 2) the techniques used to relate the wheat economies of many countries in a trade model. Each of these sections will be divided into two parts. The first section will include an initial analysis of the balance sheet structure of a wheat economy followed by an examination of some of the econometric models which have been formulated to estimate this structure. The second section will begin with an examination and comparison of world wheat trade models on the basis of their methodologies and forecasts. It will conclude with a brief discussion of some of the techniques used to predict wheat trade flows among countries.

The Structural Relationships of a Wheat Economy

The Balance Sheet Breakdown. Of primary importance in the quantitative formulation of a commodity model is the balance sheet disaggregation of the supply and demand functions. For wheat, this entails a breakdown

of supply into separate relationships, for acreage, yields, imports and carry-in stocks. The demand breakdown should include relationships for the food use, feed use and seed use of wheat, exports and carry-out stocks. This decomposition of supply and demand is justified in both economic and statistical theory.

In the estimation of economic relationships, it is often useful to separate those things which are a function of economic or policy variables from those which are not. For example, in general, wheat yields are thought to be a function of weather and technology while acreage is a function of the previous year's wheat price and policy variables. Carry-in stocks are determined by the price expectations of holders of inventories and imports will depend on the difference between the domestic and the world price of wheat. With this breakdown, it is possible to identify and estimate the relationships between the key elements of supply and the important technical, economic and institutional variables.

Like supply, the demand side can also be broken down into its major components. Each of these components represents the demand for different category of final goods. The basis for this in theory is explained by Friedman (1976, p. 153): ". . . The demand for final products reflects directly the 'utility' attached to them; the demand for factors of production does so indirectly, being derived from the demand for the final products . . ." Wheat is usually not in demand as a final product but is demanded as an input in the production of flour, bread, pastries, noodles, feed rations, alcoholic beverages, and a number of other final and intermediate products. Since wheat is used as an input in a variety of products--all of which are a function of

different economic and technical relationships--it is desireable to classify wheat demand by its uses and estimate each use separately. The most important uses of wheat are for food, feed and seed.

Carry-out and export demand represent special cases of demand. Carry-out represents wheat consumption deferred until the next time period. At that time it becomes part of the available supply.

Export demand, as was illustrated in Figure 1, is actually the excess demand of other countries for wheat. Because these countries have a different set of tastes and preferences, their utilization pattern will be different. It is therefore desireable to separate domestic consumption from foreign consumption.

Statistically, it is desireable to break wheat supply and demand down into their components as a way of limiting specification bias. This type of statistical error arises when ". . . we exclude variables, accept approximations, aggregate, and commit various other sins of omission and commission . . ." (Griliches, 1957, p. 8). By separating out the components of wheat supply and demand, it is possible to build a more correctly specified model.

Econometric Models of a Wheat Economy. One of the earliest balance sheet simultaneous models was of the United States wheat economy by Meinken in 1955. In Meinken's study, feed use, per capita food use, export demand, carry-out demand, world price and a domestic price were specified as the endogenous variables in a six equation model. Annual data for the period 1921-1938 excluding 1930 (when the federal government bought 192 million bushels of wheat and held it off the market) were used in the estimation of the model. The significant contribution of

Meinken's model was its balance sheet structure. This structure has provided the basis from which many subsequent models have been built.

One of the models which borrows from Meinken was a 1968 study of the U. S. wheat economy by Mo. The latter used annual data from 1928-1964 to estimate a six equation simultaneous model which--in contrast to Meinken--recognized the importance of government agricultural programs. Mo also took his statistical analysis a step farther than Meinken by solving for the short and long run multipliers. In this report, Mo's study stands out as an applied example of the formulation of a Tinbergen econometric policy model.

Another model which borrowed Meinken's balance sheet structure was estimated by Barr in 1973. This model covered only a 12 year time period beginning in 1960 and was much less sophisticated than the study by Mo. Barr's major innovation was the specification of price as an exponential function of food use as a percent of ending stocks. This formulation was designed to account for the short world supplies and resulting high prices that occurred in 1966 and 1972 when the Russians imported large quantities of wheat.

Barr's study is the last USDA model of the U. S. wheat economy which does not include an expanded foreign sector. After 1973, balance sheet models for American wheat no longer contained only a single export relationship. Attempts were made in USDA and elsewhere to develop more comprehensive world models for wheat because of the increased importance of exports.

World Wheat Trade Models

An Examination and Comparison of Methodologies and Forecasts. The first USDA study of the world wheat economy actually was published in 1970 (Hutchinson, Naive, Tsu). The world was divided into 22 geographic regions and wheat supply and demand projections were made out to 1980 for each region. The study was primarily a trade flow model designed to determine equilibrium quantities and prices in some future period by world regions for a given level of exogenous factors.

The 1980 projections of the Hutchinson, Naive and Tsu model indicate that ". . . world supplies of wheat should continue to be bountiful and that unless major producing countries come to grips with adjustment problems, the supplies will become too bountiful . . ." (p. 96). The South Asia region of India and Pakistan in particular was projected under the then current trends to have a substantial exportable surplus in 1980. The authors, however, were skeptical of that region becoming a major source of wheat exports because of the region's high production costs.

A somewhat similar world wheat trade model was completed by Schmitz and Bawden in 1973. They built a spatial equilibrium model for which the primary purpose was to determine ". . . the effects of space and domestic and foreign policies [including tariffs] on wheat production, prices and trade . . ." (p. 6). Schmitz and Bawden also divided the world up into regions and projected supply and demand for wheat in each out to 1980. This information along with a set of transport prices, tariff barriers, and initial domestic wheat prices was used in an algorithm which solved for the optimum trade pattern and the resulting set of equilibrium prices.

Schmitz and Bawden's 1985 projections led them to conclude: "A rather dismal future is predicted for the wheat economies in the large exporting regions such as Australia, Argentina, Canada and the United States . . ." (p. 63). This conclusion was based on the trend toward increased self sufficiency in wheat for the developing countries, the possibility that small increases in yields would substantially increase yields in the USSR and China, and the probable continuation of trade restrictions and tariffs in other parts of the world.

A study similar to the spatial equilibrium world trade model of Schmitz and Bawden was conducted by Grennes, Johnson and Thursby for all grains in 1978. This study, however, was designed to provide a set of structural relationships rather than a set of projections. Wheat comprises one sector of the model and the authors use the estimated parameters to determine the response of the world wheat economy to changes in various variables.

The most comprehensive world wheat trade forecasting model to date is the combined grain, oilseed and livestock model--better known as GOL--used by USDA (Rojko et al., 1978a; 1978b; 1978c; and Reiger, 1978). The primary contribution of the GOL model is the inclusion of the inter-relationships between the livestock sector and the grain and oilseed sectors of world agriculture. Hence, unlike the studies cited previously, the GOL model provides a measure of the interaction of wheat supply and demand with its substitutes in production and consumption.

A second advantage of the GOL model is that it provides a balance sheet breakdown of supply and demand by country. Earlier studies, at best, provided this type of breakdown for only the major developed countries.

One problem with the GOL model is that it is somewhat dated. Though the results of the model were published in 1978, all the projections are made from a 1970 base. The events of the early seventies--the dollar devaluation and the Russian wheat purchase in particular--both changed and exposed the underlying economic and institutional relationships in world agricultural trade. A more recent base year could have taken better account of this information.

Because of the organization of the GOL model, it is difficult to determine exactly what conclusions should be drawn about the 1985 projections of the world wheat economy. Under the alternative assuming no change in "current" policies and tariffs, the GOL model predicts U. S. exports to be 35.5 million tons at a real U. S. price of $65.10 per ton (Rojko et al., 1978b, pp. 65-66). In comparison with 1970 levels, exports are projected to double while prices are expected to remain about the same; im comparison with 1975 levels, 1985 exports are projected to be up by about 10 percent while prices will be down by about $90 to $100 per ton.

The most optimistic forecast of future wheat prices comes from a model at Agriculture Canada--USDA's Canadian counterpart. This world wheat simulation model was developed by Zwart and Lattimore (1977) and follows the technique of previous models of estimating wheat supply and demand functions for different regions of the world and then incorporating these results into an algorithm to solve for a world equilibrium. The model is not as detailed as the GOL model and it differs from the models of Schmitz and Bawden (1973) and Grennes et al. (1976) because it excludes transport costs and solves for a single world price.

The parameters for the Zwart and Lattimore simulation are estimated from annual data for the period 1955-1972. Using the 1975/76 crop year as a base, the simulation model projects gradually increasing prices for the following five year period, reaching a level of $5.02 a bushel at the Gulf in 1980. The authors do not report their forecast of exports in 1980 but their price and ending stock projections indicate that they expect supplies to remain tight until the end of the decade.

Recent studies at USDA have tended to stress the interdependence of the United States and the world wheat market. A technical bulletin that is soon to be published by Gallegher et al. (1978) incorporates a more detailed geographic breakdown of the foreign demand for American wheat into a model of the U. S. wheat economy. The findings indicate--as has been found in previous studies--that the policies of Japan and the EEC stabilize domestic prices at the expense of world and U. S. prices.

Techniques Used to Predict Trade Flows. The trade models presented above can be divided into two categories based on whether their final solution provides a prediction of trade flows or not. For example, the studies by Zwart and Lattimore (1977), Hutchinson et al. (1970), and the GOL model do solve for the equilibrium prices, supplies and demands for all of the specified regions but they do not determine which exporters will supply wheat to which import markets. In order to ascertain this trade pattern, an added degree of sophistication is required. The question of what determines the flow of wheat from a particular exporter to a particular import market must be answered.

The Schmitz and Bawden study implies that transportation costs are the major determinant of these flows. Their spatial equilibrium

solution provides a set of flow projections based on shipping costs between importing and exporting regions.

Grennes et al. (1978) maintain that transportation costs are not a sufficient explanation of trade flows. Wheat, they say, is not a homogenius product but is differentiated with respect to quality, transportation costs, the time of year it was harvested and the country in which it was produced (e.g., political ties may be important to some importers). All of these differences, fortunately, are primarily a function of the country in which the wheat is produced. This enables Grennes et al. to incorporate into their study a theoretical model by Armington (1969) designed to determine the demand for products distinguished by place of production. Grennes et al. are thereby able to determine trade flows based on the country of origin.

The method used by Gallagher et al. (1978) to determine trade flows was market share analysis. The theoretical method for this analysis was first developed by Telser in 1962. In 1971, Sirhan and Johnson (1971) used a market share model to estimate the foreign demand for American cotton. They specified the American share of a particular import market to be a function of the American share in the previous years and the ratio of the U. S. price to the average of the other exporters' prices.

The advantage of the market share approach is that it implicitly takes account of transportation costs, quality differences, trade barriers and preferences, etc. since these are the historical factors which have determined trade flows--without the complexity and cumbersome assumptions of the Armington model. Though other ways of estimating trade flows have been developed, the market share approach for most

purposes is the simplest, the most flexible and the most theoretically sound method now available.

Not all elements of the theory and the models covered in this chapter will be used in the analysis to follow. That would not be possible since some of the theories and techniques are incompatible. The broader purpose of this chapter, however, has been to put the current study in perspective of what has gone before and thereby provide the reader with an insight into the contributions of this work. In this respect, this chapter has presented but a small sample of the breadth and depth of the literature on trade theory and models. It is hoped that this sample will be adequate for the intended purpose.

CHAPTER III

BALANCE SHEET FORECASTING MODELS OF COUNTRIES AND REGIONS

As was explained in the previous chapter, a balance sheet breakdown of an individual country's wheat economy will permit the separate estimation of those elements of supply and demand which are functions of different independent forces. In this chapter, balance sheet components will be estimated for each important wheat importing and exporting country. The individual countries of lesser importance in world wheat commerce will be aggregated into major geographic regions of the world for which simple supply and utilization trends will be estimated.

There are, then, two areas of disaggregation in this model: a disaggregation of wheat supply and demand into balance sheet components and a disaggregation of the world into the countries and regions which are significant in international wheat commerce. In both areas there is what might be called an "optimal" level of disaggregation. If the geographic or balance sheet breakdown is too fine, needless complexity and detail will be added to the model; if the breakdown is inadequate, significant forces in world wheat trade may be altered or obscured. It is therefore important to choose for individual analysis only those components and countries which will have a significant impact on world wheat trade. The balance sheet components to be estimated will be considered first.

Identification of Balance Sheet Components to be Estimated

For wheat, the balance sheet identity can be shown as follows:

$$\text{Production} + \begin{matrix}\text{Carry-In}\\ \text{Stocks}\end{matrix} + \text{Imports} = \begin{matrix}\text{Food}\\ \text{Use}\end{matrix} + \begin{matrix}\text{Feed}\\ \text{Use}\end{matrix} + \begin{matrix}\text{Seed}\\ \text{Use}\end{matrix} + \begin{matrix}\text{Other}\\ \text{Uses}\end{matrix} + \begin{matrix}\text{Carry-Out}\\ \text{Stocks}\end{matrix} + \text{Exports}$$

Since the objective of this approach is to project future levels of export supply (import demand), the identity can be solved for net exports (net imports). It is safe to assume that other uses are relatively insignificant and that, for most countries, except the major exporters, inventory stocks represent primarily pipeline stocks with only small differences between carry-in and carry-out stocks. The balance sheet identity will therefore reduce to:

$$\text{Production} - \begin{matrix}\text{Food}\\ \text{Use}\end{matrix} - \begin{matrix}\text{Feed}\\ \text{Use}\end{matrix} - \begin{matrix}\text{Seed}\\ \text{Use}\end{matrix} = \begin{matrix}\text{Net}\\ \text{Exports}\end{matrix}$$

With estimates of these four balance sheet components (production, food use, feed use, and seed use), it will be possible to trace changes in world supply or demand to particular sectors of the wheat economies of the important importing and exporting countries.

Identification of Geographic Aggregations for Estimation

All the countries shown in Table II are to be singled out for a balance sheet analysis of their wheat economies with the exception of the Soviet Union and the People's Republic of China for which adequate

TABLE II

GEOGRAPHIC AGGREGATIONS USED IN MODEL ESTIMATIONS

Western Europe	
	Germany, Italy, Netherlands, France, United Kingdom
	Rest of Western Europe
Africa	
	Egypt
	Rest of Africa
Asia (Excluding People's Republic of China)	
	India, Japan
	Rest of Asia
Latin America and the Caribbean	
	Argentina, Brazil
	Rest of Latin America and the Caribbean
Communist Countries	
	Soviet Union, People's Republic of China, Eastern Europe
North America	
	Canada
Oceania	
	Australia
	Rest of Oceania

data were not available. For the regional aggregates and the Communist countries, single wheat production and domestic utilization equations were estimated.

All of the individual countries identified had at least five percent of the world wheat import or export market at some time during the study period with the exception of the Netherlands, which was singled out because of its central place in European commerce. Note that the country with the largest share of the world's wheat trade--the United States--is not included. The balance sheet components for the United States will be estimated instead as a part of a simultaneous equation model developed in Chapter V.

Much of the discussion of the logic of the geographic breakdown to be used fits better into the analysis of each individual region. A more detailed evaluation of the importance of each individual country in the context of world wheat trade will therefore be considered as a part of the regional analyses to follow.

The Data

The 1960-1976 series of annual data used in this study were obtained primarily from four sources: 1) the International Wheat Council (IWC), 2) the Food and Agriculture Organization of the United Nations (FAO), 3) the United States' Foreign Agricultural Service (FAS) and 4) the Organization for Economic Cooperation and Development (OECD). The names and definitions of all the variables used in the balance sheet estimations are given in Appendix A. The dependent variables are defined first, followed by a list of independent variables in the order in which they first occur. The actual country and region balance sheets developed from the four primary sources above are given in Appendix B.

For each of the balance sheets listed, an error term is given which shows the amount by which the total supply and total demand fail to balance in each year. There are two reasons the balance sheets fail to balance. First, the data for a given balance sheet may come from two or three different sources. The data collection and accounting techniques may differ among sources resulting in a discrepancy when figures from these sources are summed together.

Second, an adjustment was made to put all balance sheet data and prices in terms of a July/June crop year. This method used assumed that the change in the given variable was constant from one year to the next and that by adding the fraction of the amount by which the variable changed to the value of the variable, a reasonable approximation of the July/June level of the variable is obtained. When large changes in a variable occurred and when the direction of change was erratic, the crop year adjustment method tended to understate the true change. On the balance sheets, this resulted in large error term values for 1972-1975 when there were major disturbances on the international wheat market.

The Organization and Method of Presentation of the Balance Sheet Results

The presentation of the balance sheet estimates will be organized according to the major geographic regions given in Table II. In each geographic section there will first be a discussion of regional, institutional, political, economic, social, and physical characteristics which affect wheat trade, production, and consumption. This will be followed by an analysis of the countries in the region which have been singled out for detailed balance sheet analysis. A total of 12 countries have

been selected for detailed study. In general, six equations will be estimated for each of the 12 individual model countries. On the supply side, production will be estimated using two different methods. One method estimates production indirectly by first obtaining equation estimates for wheat hectares harvested (HH) and wheat yields (YLD). The product of the predictions of these two equations yields an estimate of production. For the second method, a production (PDN) equation is estimated directly. The advantage of the first method is that it allows for the separation of yields--a variable primarily affected by weather--and hectares harvested--a variable that is primarily a function of economic and institutional forces. The second method is desirable for its simplicity. In cases where the results of the two methods are the same, the simpler method will be used. Otherwise, the method with best fit which conforms to economic theory will be employed.

On the demand side, equations for food (FOOD), feed (FEED), and seed (SEED) use will be estimated. In Chapter IV, these will be summed to obtain projections of total wheat utilization (DU) in each of the model countries.

Finally, each geographic section will conclude with an estimate of the aggregate supply and utilization relationships for the remainder of the region. As a rule, the majority of the discussion and analysis will focus on individual countries since the "rest of the region" estimates are at too high a level of aggregation to determine the influence of common economic and institutional variables. Therefore, the regional aggregate estimates will be designed primarily to identify wheat production and utilization trends.

Western Europe

Western Europe is one of the primary wheat consuming and producing areas of the world. In the past 30 years wheat consumption has outstripped production and the region has had to import the balance--usually from the U. S., Canada, or Argentina. As the results of this section will show, it appears that Western Europe is approaching self-sufficiency in wheat and that short of a major change in the agricultural policy of the EEC--the future market for wheat imports in Europe may be restricted to varieties which cannot be produced in the area.

Geographic Delineation of the Region

For the purposes of this study, Western Europe was broken down into five countries--Germany, Italy, the Netherlands, France and the United Kingdom--and one remaining region designated as the "Rest of Western Europe" containing the aggregate of the unspecified countries. The reasons for specifying Germany, Italy, France and the United Kingdom are obvious--they are the major wheat consuming, producing and importing (exporting) countries in the region. Even though the Netherlands is not important when judged by these standards, it does hold a central place in the international agricultural commerce of the European Economic Community. The port of Rotterdam handles a large volume of the wheat destined for Western Europe and a relatively lengthy series of what prices exists for wheat entering Rotterdam from the U. S., Canada and Argentina.

In contrast to some recent studies (Grennes et al, 1978) the EEC is not considered a national entity in this study. There are three reasons

for this. First, though the European Community was in existence for the length of the study period, a uniform policy linking together the agricultural policies of member states did not take effect until the Common Agricultural Policy (CAP) began in 1967. Second, the United Kingdom, Ireland and Denmark did not actually join the Common Market until 1973 although their agricultural policies were gradually adjusted to those of the CAP beginning in 1971. The EEC before and after these recent entrants cannot be considered the same unit.

Finally, due to exchange rate changes among the member nations in the last ten years, it is no longer clear that a uniform agricultural policy exists. Particularly since a system of floating exchange rates--which fluctuate frequently--replaced the Bretton Woods Agreement of fixed exchange rates in 1973, it has been difficult for the governing body of the EEC to maintain parity in economic policies and tariffs. Individual country estimations should give a clearer picture of agricultural developments within the EEC.

This, of course, does not mean that the EEC is unimportant in the analysis to follow. As will be seen, the Common Agricultural Policy not only plays a central role in projecting the wheat supplies and demands of member countries, but has major influence on non-member countries in the region as well. For this reason, a special section is devoted to the explanation of the agricultural and trade policies of the European Economic Community.

Agricultural and Trade Policies of the European Economic Community

The purpose of the EEC--as with any customs union--is to promote

trade among the member nations at the expense of trade with nations outside the Community. Tariffs, levies, and pricing policies are the primary traditional instruments used in achieving these objectives although the establishment of common standards and regulations are often of equal importance.

Perhaps the area in which the EEC has been the most successful has been agriculture and the instrument of this success in the Common Agricultural Policy (CAP). The CAP is a comprehensive common agricultural pricing and tariff policy. Although transitional regulations for the CAP were initiated in 1962, the major provisions of the policy did not take effect until 1967.

Briefly, the Common Agricultural Policy has five policy objectives: 1) increasing agricultural productivity, 2) maintaining a fair standard of living for the rural population, 3) stabilizing markets, 4) assuring regular supplies, and 5) maintaining reasonable consumer prices (USDA, 1968, p. 5). To achieve these objectives a common pricing mechanism has been established throughout the Community for designated commodities. This internal pricing structure is maintained by a system of variable tariffs which effectively precludes price competition from commodities produced outside the Community.

For cereals (wheat, barley, rye and maize), a target price is set each year for the succeeding crop year. The target price for grain is a fixed wholesale price for Duisburg, Germany--the largest marketing center in the Community where grain is in shortest supply. The basic intervention price is set below the target price and is the floor below which the EEC will not allow prices to fall. When prices get near this floor, designated Community intervention and marketing centers are

obligated to accept all quantities of grain offered to them at intervention prices discounted for transportation costs to Duisburg and adjusted for local surplus or deficit conditions. Hence, local producer prices can differ considerably within the Community.

A market ceiling is essentially provided by the threshold price which is the minimum price at which imports are allowed to enter the EEC. This price is set at Rotterdam and when transport costs from Rotterdam to Duisburg are added, the cost of the imported grain will be at or above the target price. The variable levy on a particular grain is calculated as the difference between the threshold price and the lowest adjusted c.i.f. price at Rotterdam for that grain. This levy is adjusted daily for changes in world market prices and is collected on all imports of that grain regardless of the actual price of the shipment.

The variable levy system insures that the cheapest and lowest quality import wheat, for example, will always be more expensive than Community produced wheat regardless of the location within the EEC, the time of year or the quality of EEC wheat. In general, this has meant stable but relatively high grain prices within the European Community. The only exception has been a short period in 1973 when world wheat prices exceeded intra-EEC prices. The Community responded by placing an embargo on wheat exports in an attempt to keep prices from exceeding the threshold level.

In addition to the policies which apply to all grains, there are a few EEC policies which have been designed specifically for wheat. One important policy toward wheat arose because "Although wheat production has exceeded Community requirements for a number of years, the wheat produced is primarily soft wheat, leaving an import requirement for high

quality hard wheat . . ." (Berntson et al., 1969, p. 17). At the same time, the EEC does not produce enough feed grains to meet its own needs. Hence, the Community instituted a subsidy called a "denaturing premium" to encourage the feed use of wheat. The denaturing premium began as a unified Community policy in 1967 and lasted until 1973 when short wheat supplies resulted in a phase out of the subsidy. This denaturing premium has been in part responsible for the large amount of wheat used for feed in the European Economic Community and, as shown in the regression results to follow, it has been an important factor in the variation of European wheat consumption.

The Five European Model Countries

Because all five of the individual European model countries are affected by many of the same policies, the balance sheet estimation results will be discussed in general with country differences and similarities being pointed out. This section will conclude with a comparison of the impact of the CAP on Italy and Germany.

Supply. A number of different independent variables were considered in an attempt to explain the variation in each of the five model countries' production, yields and areas harvested, but, in the final analysis, technology and the beginning of the Common Agricultural Policy turned out to be the most important. Trend (YR) was used as a proxy for technological change and a dummy variable (D6776) and dummied trend (DYR6776) were used to account for the CAP. The only country for which the CAP was not a significant variable in at least one of the three supply equations was the United Kingdom. This possibly is because the

TABLE III

BALANCE SHEET EQUATIONS ESTIMATED FOR GERMANY

Statistics	Dependent Variables[a]					
	HHG	YLDG	PDNG	FOODG	FEEDG	SEEDG
Intercept	1391	-2.08	4625	5539	6269	244
Regression Coefficients						
YR		.087		-27		
(t)		(5.23)		(1.91)		
D6776	-1488		-9360	-3049		-397
(t)	(-5.03)		(-2.68)	(-2.83)		(-4.69)
DYR6776	22		158	43		5.98
(t)	(5.56)		(3.26)	(2.65)		(5.05)
DPPLCG					-6.74	
(t)					(-7.96)	
D7476					-43786	
(t)					(-2.56)	
DYR7476					577	
(t)					(2.53)	
Mean	1483	3.88	5786	3784	2435	262
R^2	.88	.64	.86	.64	.84	.80
DW	1.69	1.93	2.09	1.46	1.88	2.87

[a]See Appendix A for a definition of variables and their units.

TABLE IV

BALANCE SHEET EQUATIONS ESTIMATED FOR ITALY

Statistics	Dependent Variables[a]					
	HHI	YLDI	PDNI	FOODI	FEEDI	SEEDI
Intercept	8484	-1.62	-13466	-1872	683	1220
Regression Coefficients						
YR	-64	.057	350			-7.44
(t)	(-10.69)	(8.60)	(3.55)			(-5.39)
D6776			26340			
(t)			(3.53)			
DYR6776			-397			
(t)			(-3.48)			
D6773					2782	
(t)					(-2.63)	
DYR6773					40	
(t)					(2.67)	
RWCRNPI					-38	
(t)					(-3.13)	
POPI				201		
(t)				(4.87)		
Mean	4092	2.26	9156	8779	181	714
R^2	.88	.83	.66	.61	.64	.66
DW	1.67	1.68	2.16	1.93	2.17	1.64

[a]See Appendix A for a definition of variables and their units.

TABLE V

BALANCE SHEET EQUATIONS ESTIMATED FOR THE NETHERLANDS

Statistics	Dependent Variables[a]					
	HHN	YLDN	PDNN	FOODN	FEEDN	SEEDN
Intercept	208	4.38	167	2025	1554	-58
Regression Coefficients						
YR	5.5		7.11	-15		1.28
(t)	(3.04)		(1.90)	(-2.53)		(2.38)
D6776	631	7.15		-1041		104
(t)	(4.62	(-2.45)		(-2.22)		(2.56)
DYR6776	-9.45	.106		.15		-158
(t)	(-4.51)	(2.63)		(2.15)		(-2.53)
DPPLCN					-2.04	
(t)					(-3.27)	
DYR7476					-6.42	
					(-3.08)	
Mean	139	4.67	651	993	282	23
R^2	.64	.50	.19	.67	.46	.40
DW	2.25	2.72	2.43	2.35	2.06	1.42

[a]See Appendix A for a definition of variables and their units.

TABLE VI

BALANCE SHEET EQUATIONS ESTIMATED FOR FRANCE

Statistics	Dependent Variables[a]					
	HHF	YLDF	PDNF	FOODF	FEEDF	SEEDF
Intercept	4238	-4.51	-14367	11340	-10963	1368
Regression Coefficients						
YR		.11	421	-88	222	-9.3
(t)		(6.56)	(4.93)	(-4.39)	(2.47)	(-3.83)
D6776	-240			-3492	17502	
(t)	(-2.27)			(-2.29)	(2.57)	
DYR6776				48	-262	
(t)				(2.07)	(-2.52)	
Mean	4097	3.49	14270	5297	3445	731
R^2	.25	.74	.61	.95	.52	.50
DW	2.93	1.45	2.32	1.27	2.32	1.75

[a]See Appendix A for a definition of variables and their units.

TABLE VII

BALANCE SHEET EQUATIONS ESTIMATED FOR THE UNITED KINGDOM

Statistics	Dependent Variables[a]					
	HHUK	YLDUK	PDNUK	FOODUK	FEEDUK	SEEDUK
Intercept	-702	4.09	-5105	5169	-8665	-166
Regression Coefficients						
YR	24.79		134		170	5.34
(t)	(6.11)		(5.14)		(3.89)	(6.91)
D7176					17197	
(t)					(2.01)	
DYR7176					-243	
(t)					(-2.06)	
Mean	984	4.09	4061	5169	2681	197
R^2	.71		.64		.66	.76
DW	2.43		1.95		2.85	2.24

[a]See Appendix A for a definition of variables and their units.

CAP took effect at a much later date (1971) for the UK[1] at a time when the impact was obscured by disturbances in the world wheat market.

The criterion for choosing between a straight production equation (PDN) and an equation calculated from the product of the yield (YLD) and area harvested (HH) estimates was to take the alternative which most clearly reflected the impact of the CAP. For Germany and Italy, the production equation provided the best fit while the product of yields and area harvested was more suitable for France and the Netherlands. In the United Kingdom where the CAP was not a factor, the calculated relationship was used because it resulted in a more conservative forecast which appeared to be warranted given the last two years' production.

Demand. Food use is the balance sheet component which accounts for the greatest proportion of domestic utilization in each of the five countries. Again, changes in the trend due to the CAP explained food use of wheat in three of the five countries. In Italy, population was found to be a good explanation while food use in the United Kingdom had such a narrow variation around the mean that all attempts for explaining this variation were unsuccessful. Hence, the mean itself was used as the predictor.

Though feed use is much smaller than food use in all five countries, it accounted for the largest part of the variation in domestic utilization in every country. The feed use equations for Germany, Italy and the Netherlands are similar because they are all a function of a price and the discontinuation of the denaturing premium. Italy is somewhat

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[1]The United Kingdom joined the EEC in 1973 but an adjustment of UK agricultural policies to coincide with the CAP was begun in 1971.

different from the other two in that a wheat-corn price ratio (RWCRNPI) is used instead of a deflated producer price and because the dummy and dummy slope specified account for the period from the beginning of the CAP to the discontinuation of the premium (rather than specifying the discontinuation alone).

France and the United Kingdom show feed use to be a function of trend and the changes brought about with the adoption of the CAP. In neither country was feed use found to vary significantly with price.

Seed use, in general, fluctuates with the area planted and, to a lesser extent, with the area harvested. All of the seed use equations had the same empirical specification as their respective area harvested equations.

Italy and Germany: A Comparison of the Effect of the CAP. A plot of the predicted and actual demand and supply for both Italy and Germany is shown in Figure 5. In the early 1960's, both countries tended to consume more wheat than they produced. In Italy, however, production was trending upward faster than utilization while in Germany both production and utilization were relatively flat. When the CAP came into effect in 1967, Italy is shown to be self sufficient in wheat. It was at this point that trends changed in both countries. In Germany, both wheat production and utilization began to increase while Italian wheat production began to decline falling well below utilization. With the discontinuation of the denaturing premium in 1974, demand fell and Germany produced a substantial surplus. The end of the denaturing premium in Italy caused demand for wheat to taper off somewhat but not enough to change the country's net wheat deficit situation.

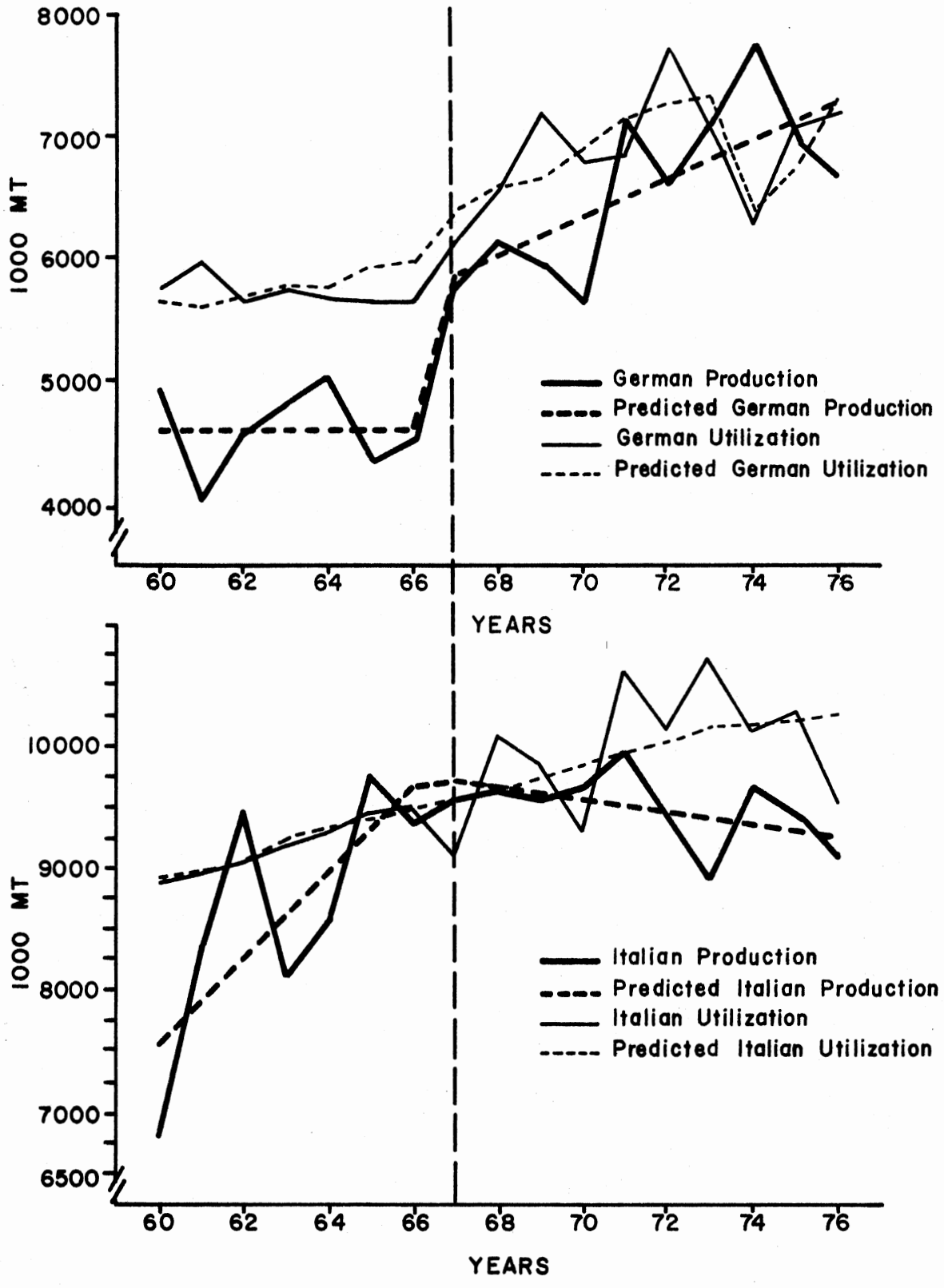

Figure 5. A Comparison of the Impact of the Common Agricultural Policy on Italy and Germany

This example shows that the effect of the Common Agricultural Policy on member countries' wheat economies was not uniform. The effect on the German wheat economy reflects the general pattern while Italy is the exception. But this exception would not have been identified had an EEC aggregation been used instead of the individual country analysis.

Rest of Western Europe

The Rest of Western Europe is composed of the remaining countries in the EEC (Belguim, Luxemburg, Denmark, and Ireland) and the non-Communist countries of Europe outside the EEC. Total wheat production by this group of countries is shown in Table VIII to be a function of time. Domestic utilization of wheat, on the other hand, appears to be heavily influenced by the policies of the EEC. Wheat utilization was stable until the beginning of the Common Agricultural Policy in 1967 after which it increased at a steady rate. This probably reflects the effects of the EEC subsidy on agricultural exports to the countries outside the Community. The dummy variable in the equation for 1973 (D73) accounts for the embargo on wheat exports by the EEC in that year.

At the beginning of the study period domestic utilization in the Rest of Western Europe was about 3.5 million tons greater than production. By the end of the period this "deficit" had shrunk to about 1.2 million tons due to the more rapid increase in wheat production relative to utilization. If this trend continues, the region will become self sufficient in wheat in the near future.

TABLE VIII

BALANCE SHEET EQUATIONS ESTIMATED FOR THE REST OF WESTERN EUROPE

Statistics	Dependent Variables[a]	
	PDNRWEU	DURWEU
Intercept	-4076	17114
Regression Coefficients		
YR	294	
(t)	(4.62)	
D6776		-13878
(t)		(-6.11)
D73		-1289
(t)		(4.24)
DYR6776		214
(t)		(6.74)
Mean	15961	17884
R^2	.59	.92
DW	2.75	1.84

[a]See Appendix A for the definition of variables and their units.

Africa

For Africa, there are no major world exporters of wheat and Egypt is the only major importer (the latter accounts for about 40 percent of Africa's wheat imports and about five percent of total world imports). Therefore, Africa is analyzed as two regions: Egypt and the Rest of Africa.

Egypt

The major thrust of Egyptian policy with respect to wheat is the provision of a cheap source of food for the population. As a result, ". . . Demand for agricultural imports has accelerated in Egypt because prices for basic commodities have remained fixed at artificially low levels, while urban population and income have been rising faster than anticipated . . ." (Parker, 1977, p. 4). Unfortunately, for farmers, this policy also means low government set producer prices for wheat. Hence there is little incentive to increase production of wheat.

Supply. The production of wheat in Egypt is related to the lagged deflated government-fixed producer price. Because the direct estimation of production (PDNE) did not have a significant price variable--as shown in Table IX--the product of the area harvested (HHE) and yield estimates (YLDE) were used for projection purposes.

The wheat area harvested in Egypt is a positive function of the previous year's producer price. A lagged ratio of the producer price of wheat to the producer price of corn gave similar statistical results but was less effective in forecasting the downward turn in area harvested in recent years.

TABLE IX

BALANCE SHEET EQUATIONS ESTIMATED FOR EGYPT AND THE REST OF AFRICA

	Dependent Variables[a]					
	Egypt				Rest of Africa	
Statistics	HHE	YLDE	PDNE	FOODE	PDNRAF	DURAF
Intercept	387	2.53	1179	-8859	12427	21772
Regression Coefficients						
YR				191	271	454
(t)				(8.08)	(7.23)	(26.71)
LDPPLCE	.37		.087			
(t)	(3.16)		(.73)			
D6976		-8.16				
(t)		(-3.98)				
DYR6976		.12				
(t)		(4.26)				
D6876				8833		
(t)				(-4.25)		
DYR6876				116		
(t)				(3.77)		
Mean	562	2.82	1583	3955	6011	9127
R^2	.42	.80	.04	.98	.78	.98
DW	2.26	2.13	.55	.85	1.86	1.90

[a]See Appendix A for a definition of variables and their units.

Like area harvested, yield is a function of the producer price of wheat but the latter equation has a different specification. Wheat yields in Egypt were relatively constant until 1969 when a change in government pricing policies resulted in an upward trend. A dummy variable and a dummied trend is used to reflect this change of policies in the yield equation.

Demand. Only the food use component of domestic utilization was estimated for Egypt because 1) feed use was insignificant for most of the 17 year study period and 2) seed use was reported to be a constant 100,000 tons since 1970. Trend was used to explain the growth in the food use of wheat along with a dummy and a dummied trend for international financial problems which arose in Egypt following the 1967 Arab-Israeli war. The foreign reserves with which Egypt purchased wheat imports were severely depleted by 1968. A lower level of imports forced a lower level of wheat consumption on the population.

Although a relation for feed use was not estimated, it became more significant near the end of the study period. This may be the result of very low government-imposed wheat prices. Instead of selling their wheat to the government purchasing agency in 1976, ". . . Most farmers chose to sell their wheat to their neighbors . . . " (Parker, 1977, p. 7). Much of this wheat may have been used to feed animals.

Rest of Africa

For the rest of Africa, production and domestic utilization of wheat were estimated using trend. A comparison of the two trend coefficients reveals that wheat utilization in Africa is increasing at almost twice

the rate of wheat production. It appears that rapid urbanization and growing western influence would make Africa one of the fastest growing wheat import markets in the world.

Asia

The continent of Asia is an extremely large land mass encompassing a variety of climates and cultures. In terms of food grain production and consumption, the continent can be viewed as two separate areas. In the northern and western parts of Asia, wheat is the major food grain while in the south and east rice is most important and wheat is second.

Since the USSR and the People's Republic of China are to be discussed separately later, India and Japan are the only two remaining countries of the continent which are significant in international wheat commerce. India and Japan are both major wheat importers and India is one of the world's largest wheat producers.

India

Supply. The growth in Indian wheat production over the last decade has been remarkable. Two factors have been responsible for this growth. First, in 1968 new higher yielding varieties of wheat were introduced into the wheat growing regions of the country. Second, this was coupled with an effort by the government to bring more acres under irrigation using inexpensive tube wells with diesel or electric motors. (See IWC 1967/68a, p. 57.) The result has been steadily increasing wheat production since 1968, except for the crop years 1973/74-1974/75 when production was limited by adverse weather and shortages of fertilizers and irrigation equipment. (See IWC 1973/74a, p. 41 and IWC 1974/75a, p. 39,)

TABLE X

BALANCE SHEET EQUATIONS ESTIMATED FOR INDIA

Statistics	Dependent Variables[a]					
	HHIN	YLDIN	PDNIN	FOODIN	FEEDIN	SEEDIN
Intercept	8340	-1.82	3697	-46797	29.6	
Regression Coefficients						
YR		.042		974		
(t)		(8.45)		(14.13)		
D6876	-55042		-102760			
(t)	(4.51)		(-3.92)			
DYR6876	828		1595			
(t)	(4.91)		(4.35)			
DWPLCIN2			5.03			
(t)			(1.40)			
PDNIN					.011	
(t)					(12.50)	
HHIN						.105
(t)						
Mean	15880	1.06	17699	19437	219	1655
R^2	.95	.82	.95	.93	.91	
DW	1.68	1.10	2.02	.98	1.38	

[a]See Appendix A for a definition of variables and their units.

The supply estimates in Table X take account of the changes in seed and irrigation use through the use of a dummy variable and a dummied trend for the period from 1968-1976. In addition to these two independent variables, both the production and area harvested equations are a function of a lagged deflated wholesale price of wheat in India. Yields in India were specified strictly as a function of technology (trend). Though the inclusion of a dummy variable to change the slope and intercept would have provided a better fit and a more reasonable Durbin-Watson statistic, it was felt that this latter specification would lead to overly optimistic yield projections.

For the purposes of projection, the direct estimation of production appeared to provide somewhat better estimates than the indirect estimation using area harvested times yields because the influence of price was stronger in the former.

Demand. The domestic utilization equations estimated for India are relatively simple. Food use was determined to be a function of time. Though food use estimates using population as the independent variable were very similar, it was felt that time was easier to use for projections.

Feed use in India is very small in comparison with food use. It was found to be dependent on the amount of wheat produced indicating that given a large wheat crop, producers would feed some of it to livestock.

Seed use in India was estimated using the number of hectares harvested times a constant use per hectare. This was preferrable to using a regression since seed data for the early part of the period had

to be generated using a ratio of seed use to hectares harvested for the years for which data were available.

On the whole, India's need to import wheat has decreased substantially over the past ten years. The policies of the government to encourage wheat production have resulted in a rate of increase for production that has, on the average, been greater than the increase in demand. The result is that India is approaching self-sufficiency in wheat.

Japan

Supply. Japan's wheat production had been steadily declining until 1973 when it appeared to hit a floor in the neighborhood of 225 thousand metric tons. As expected, this reflects a declining hectarage devoted to wheat. The area harvested has declined from over 650 thousand hectares in 1961 to a floor of about 85 thousand hectares in the 1973-1976 period. Yields in Japan have not shown any significant trend.

The left half of Table XI shows the supply equations estimated for Japan. Although both the production and area harvested equations have parameters that will result in lower future projections, the minimum level appears to already have been reached. Hence it is assumed that from 1973 forward, production and area harvested are likely to be maintained at a level of 225 thousand tons and 85 thousand hectares respectively. Yields were projected to remain at their mean for the past two decades.

Demand. Food use in Japan has been increasing over the study period and was found to be a function of the deflated producer price of rice (a proxy for the retail price of rice) and per capita GNP in 1975 billions

TABLE XI

BALANCE SHEET EQUATIONS ESTIMATED FOR JAPAN AND THE REST OF ASIA (EXCLUDING CHINA)

	Dependent Variables[a]							
	Japan						Rest of Asia (Excluding China)	
Statistics	HHJ	YLDJ	PDNJ	FOODJ	FEEDJ	SEEDJ	PDNRAS	DURAS
Intercept	3147	2.53	7476	-2706	740	1.11	46693	-61687
Regression Coefficients								
YR	-41.4		-97.8	76			1075	1390
(t)	(-19.15)		(-9.37)	(15.95)			(11.69)	(22.08)
DPPRCJ				6.05				
(t)				(5.00)				
LDXRAWPJ					.002			
(t)					(-2.17)			
HHJ						.057		
(t)								
Mean	335	2.53	826	3940	602	20	26424	32868
R^2	.96		.85	.97	.25	.95	.90	.97
DW	.65		2.02	2.00	1.08	.78	1.38	.96

[a]See Appendix A for a definition of variables and their units.

in yen. The variation in feed use over the past 20 years has been more difficult to explain. The producer prices of wheat and barley did not appear to be correlated with the feed use of wheat. However, a lagged deflated average imported wheat price corrected for exchange rate changes between the U. S. and Japan provided some explanation for changes in the feed use of wheat.

Japanese seed use has followed a pattern very similar to that of production and area harvested, declining to a minimum level of about eight thousand metric tons in the early 1970's and remaining at that level. As expected, seed use was estimated as a function of area harvested as shown in Table XI.

Rest of Asia (Excluding China)

For the rest of the Asian continent, excluding China and the USSR, production and utilization were estimated using trend. As is evident from the equations in Table XI, the utilization of wheat for the rest of Asia is not only greater than production, but it is also increasing at a faster rate. Therefore, non-communist Asia as a whole represents an expanding market for wheat imports.

Latin America and the Caribbean

In South America two countries were estimated separately: Brazil, the major wheat importing country of the region and Argentina, the major wheat producing and exporting country of the continent. The estimation of equations for both of these countries brought to light two difficulties which, up to this point, have been of little significance in estimating equations for other regions: inflation and the different crop year.

Inflation is clearly the greatest of the two problems. During the study period (1960-1976) both countries had suffered from significant levels of inflation. Brazil's yearly inflation rate had been as high as 90 percent in 1963. It later decreased and averaged about 20 percent a year until 1975 when it shot up to a rate of 43 percent. For Argentina, the inflation problem was even worse. At the beginning of the period the annual inflation rate was from 20 to 30 percent but by 1971 the situation began to deteriorate and by 1975 the Argentine currency was devaluating at a hyper-inflation rate of 500 percent a year. These rates of inflation pose serious problems in determining the impact of prices on the wheat economies of the respective countries. At high rates of inflation, the choice of an index to deflate prices is of relatively greater importance than in a case where the rate of inflation is only three to four percent a year. A deflator based on the last three months of the year--during the period of the wheat harvest--may be more appropriate (and much different) than a deflator based on the average rate of price increase for the entire year.

Finally, inflation brings into question the nature of the response of producers and consumers to the price system. Even if prices are "correctly" deflated so that they reflect the real value of the good in question, the market participants may not correctly anticipate inflation and they may act on a different set of decision criteria. It is impossible to know whether the market participants are reacting to real price changes or some unknown perceived price change. It is likely that as the variance of the rate of inflation increases, anticipated and actual price changes diverge.

The second problem area encountered in the South American continent was that of the radically different crop year. In contrast to the July/June crop year which is prevalent in countries of the northern hemisphere, South American countries (and Australia to be discussed later) have wheat crop years with the wheat harvest occurring in a three month period from November through January. Although wheat data have been adjusted to approximate the levels of production, stocks and consumption on a July/June year basis, they are not strictly comparable with the data of northern hemisphere countries.

Brazil

Supply. Production of wheat in Brazil over the study period showed no trend until 1967 when the government initiated a ten year development plan, after that wheat production began increasing. (See USDA, 1967, p. 31.) Since yields trended slightly upward over the entire period, the production pattern primarily reflects changes in area harvested. The estimates for production, area harvested and yields are shown in the left half of Table XII. The production equation (PDNB) uses a dummy and a dummied trend to account for the change in government policies in 1967. Brazilian yields are explained with a simple trend variable and area harvested was found to be a function of the previous year's deflated producer price of wheat and trend, along with a dummy and dummied trend to reflect the 1967 change in government policies.

In the Brazilian case, the estimate calculated from yields and area harvested was preferable to the direct estimate of production primarily because it allowed deflated producer prices to play a part in determining the level of production. One shortcoming of the calculated estimate is

TABLE XII

BALANCE SHEET EQUATIONS ESTIMATED FOR BRAZIL

Statistics	Dependent Variables[a]					
	PDNB	YLDB	HHB	FOODB	FEEDB	SEEDB
Intercept	251	-2.37	10124	624	340	40
Regression Coefficients						
YR		.0453	-177		10.26	
(t)		(2.91)	(-1.67)		(2.27)	
D6776	-14441		30241			
(t)	(-4.09)		(-3.99)			
DYR6776	220		464			
(t)	(4.46)		(3.96)			
LDPPLCB			16.2			
(t)			(1.49)			
DPPLCB					-4.54	
(t)					(-2.77)	
PCYB				305		
(t)				(11.70)		
HHB						.069
(t)						(4.72)
Mean	1017	.7081	1381	2475	606	134
R^2	.80	.36	.86	.90	.67	.60
DW	2.56	2.26	1.68	.66	2.56	1.93

[a]See Appendix A for a definition of variables and their units.

that it overestimates Brazilian yields for 1975/76 and 1976/77, and this results in overly optimistic production projections. Provisional International Wheat Council data show Brazilian yields for 1977/78 to be .67 metric tons per hectare--well below the 1.12 metric tons per hectare predicted by the model. Though much of the error is due to weather factors, it is possible that forces may be at work--such as the increase in area planted--to decrease yields in the last three years.

Demand. On the demand side, food use trended upward at a gradually increasing rate over the period. Feed use increased until 1974 when there was a sharp decrease in use followed by two years in which feed use was higher but did not return to the 1973 level. Seed use followed a pattern similar to that of production.

The right half of Table XII shows the equations estimated on the demand side. Food use was found to be a function of per capita income. Note that though the R-square is .90, the Durbin-Watson statistic is only .66--well outside the acceptable region. Since food use increased at an increasing rate, it was felt that fitting a curve to this trend would result in relatively high projections of future food use that were not likely to be sustained. Hence a lower, and hopefully more realistic projection was used at the expense of autocorrelated error terms.

Brazilian feed use was found to be a function of trend and the deflated producer price of wheat. Although trend was an adequate explanation over the earlier part of the period, the deflated price was important in picking up the sharp decrease in feed use in 1974 and the recovery thereafter. Seed use was best explained as a technical relation based on the area harvested.

Argentina

Supply. Because of weather and political unrest in Argentina over the last two decades, it is very difficult to identify and quantify the forces which have consistently influenced wheat production. Although production has, in general, shown a gradual upward trend, there have been three years of large departures on the upside. In addition, both yields and area harvested are highly variable over the period and show no significant trend.

The estimates in Table XIII reflect this fact. The best predictors for yields and for area harvested were the respective means. A number of prices with different deflators and lags were tried in the production equation but, of those which were theoretically plausible, none worked as well as trend with a dummy to take out the three crop years of extraordinarily high production (1963/64, 1964/65, and 1976/77). Hence, based on the experience of the last 17 years, the predictions of this production equation will be within relatively narrow limits on the down side but may substantially underestimate actual production in years when good yields and a large wheat area harvested coincide. In spite of this recognized deficiency, the direct estimation of production was much better than using production estimates calculated from the product of the means of Argentine yields and area harvested.

Demand. On the demand side, food use which has trended upward throughout the period, was best explained by population increases. In this case, per capita income was much less effective in forecasting food use--most likely due to the variation in income resulting from recurrent civil strife and shifting government policies.

TABLE XIII

BALANCE SHEET EQUATIONS ESTIMATED FOR ARGENTINA AND THE REST OF LATIN AMERICA AND THE CARIBBEAN

	Dependent Variables[a]							
	Argentina						Rest of Latin America and the Caribbean	
Statistics	HHAR	YLDAR	PDNAR	FOODAR	FEEDAR	SEEDAR	PDNRSA	DURSA
Intercept	4841	1.43	-4061	-668	648	636	4240	-2506
Regression Coefficients								
YR			150				-32	89
(t)			(2.99)				(2.08)	(12.31)
D636467			4304					
(t)			(6.68)					
POPAR				174				
(t)				(14.29)				
RLWCPAR					4489			
(t)					(-6.55)			
Mean	4841	1.43	6898	3327	178	636	2049	3583
R^2			.79	.93	.75		.22	.91
DW			2.41	1.32	.66		2.33	1.10

[a]See Appendix A for a definition of variables and their units.

Feed use was found to be a function of the ratio of the current year's wheat price to the succeeding year's corn price. This seemingly nonsensical variable is, in fact, quite logical when the different wheat and corn crop years are taken into account. The December/November wheat crop year average price is divided by the April/March corn crop year average price of the succeeding year allowing for a maximum time overlap of the two price series. Seed use was found to be highly variable and not a function of area harvested. Therefore, the mean was used as the predictor.

Rest of Latin America and the Caribbean

The aggregate of the "Rest of Latin America and the Caribbean" includes all of the countries in the Western Hemisphere except Brazil, Argentina, the United States and Canada. As in the case of other geographical aggregations, production and domestic utilization were predicted using only a trend variable. The results are shown in Table XIII. In this region production has been almost stable over the past two decades while domestic utilization has been increasing steadily. Hence, the market for wheat exports is growing quite rapidly for this group of countries.

Communist Countries

The Communist countries are among the most important in international wheat trade because they are major producers, consumers and--at times--importers of wheat. In addition to this, they are particularly significant for two reasons. First, there is a lack of reliable information on the variables and parameters which determine the supply and demand for wheat in these countries. Part of this dearth of information results

from the secrecy of the respective governments concerning yields, carry-out stocks, the distribution of output, etc., and part results from the system itself. Prices are a form of information and where market prices are not used to reflect the scarcity resources, it is difficult to say what conditions exist and how producers and consumers are likely to respond.

The second reason Communist countries are of particular importance in the world wheat trade is the variability of their purchases of wheat imports. The Soviet Union is especially notable in this regard but the other Communist countries have the potential for the same variability. These countries may respond to a crop failure by forcing a decrease in consumption or they may make up the difference with imports. The policy-making process by which these decisions are made is not open. Hence, it is difficult to anticipate how these governments will respond.

The Soviet Union

The USSR is the largest producer of wheat in the world with an annual output which has averaged 92 million tons since 1970. However, the variation around this mean has ranged from 66 to 110 million tons in that same seven year period. Part of this variation can be attributed to climatic factors since a large fraction of Soviet wheat is grown in areas of limited rainfall. Yet, as Johnson (1977) points out,

> . . . Also responsible are farming practices that neglect certain available methods to limit production variations, such as the major use of summer fallow. The variability of Soviet grain production far exceeds that in climatically similar areas in North America . . . (p. 1).

Production in the Soviet Union has been trending upward over the study period but--as noted--with wide year to year fluctuations.

Soviet officials are projecting an increase in production that will make the USSR self-sufficient in grains by 1985 but most American sources believe they will fall well short of this goal. In an analysis of the long term outlook for Russian grain imports, the Central Intelligence Agency (January 1979) predicted that,

> . . . On balance, we expect planned fertilizer applications to grain will be achieved by about 80 percent. New production capacity needed to meet output goals is slow in coming on stream. Even if production targets . . . are met, planned applications to grain cannot be made unless transportation and storage losses--currently 10 to 15 percent--are reduced, and prospects for reduction are dim (p. 3).

Hence, past production increases are probably a good indication of the levels which are likely to be achieved by 1985. The wheat production equation (PDNCCP) shown in Table XIV is based on simple trend and reflects a gradual increase in Soviet wheat output over the past 17 years.

As shown in Table XIV, the trend coefficient of 2567 on Soviet wheat domestic utilization (DUCCP) is considerably greater than the corresponding trend coefficient of 1964 on Soviet production (PDNCCP). This indicates that the demand for wheat is increasing faster than the supply which implies that the USSR will have to increase its wheat imports if current trends continue.

People's Republic of China

Of all the major wheat importing countries, data on the People's Republic of China is probably the most sparse and least reliable. The data that are available are from United Nations and USDA sources--not from internal Chinese sources. Hence, the data represent only general

TABLE XIV

BALANCE SHEET EQUATIONS ESTIMATED FOR THE SOVIET UNION, THE PEOPLE'S REPUBLIC OF CHINA, AND EASTERN EUROPE

	Dependent Variables[a]					
	USSR		People's Republic of China		Eastern Europe	
Statistics	PDNCCP	DUCCP	PDNPRC	DUPRC	PDNEEU	DUEEU
Intercept	-52503	-94141	-68931	-42581	-48882	-38063
Regression Coefficients						
YR	1964	2567	1441	1094	1016	916
(t)	(2.79)	(6.10)	(17.27)	(7.76)	(12.45)	(13.63)
Mean	81029	80438	29235	31780	20217	24233
R^2	.34	.71	.95	.80	.91	.93
DW	2.38	.63	1.73	1.45	2.00	1.77

[a]See Appendix A for a definition of variables and their units.

trends which are perceived from outside the country; there is very little variation around these trends.

The estimated Chinese wheat production (PDNPRC) and domestic utilization (DUPRC) equations are shown in Table XIV. As indicated by the respective coefficients on trend (YR), production of wheat is increasing at a faster rate than utilization. The next chapter will show how this may have important implications for world wheat trade in 1985.

Eastern Europe

The Eastern European countries are tied very closely to the Soviet Union. In the past, Eastern Europe has imported the major portion of their wheat from the USSR but since the latter is finding difficulty in meeting its own needs for grain, these countries have had to look outside the Communist bloc for wheat.

Though the Eastern European countries consume more than they produce, the trends estimated in Table XIV point to a gradually diminishing wheat deficit. Yet while unlike the estimates for the People's Republic of China, the difference between production and utilization for Eastern Europe will not be closed in the near future.

Canada

Policy and Characteristics

Since Canada is second only to the United States as a major world exporter of wheat, it is important to know the economic and institutional factors that affect the exportable supplies of Canadian wheat. In

Canada, the Canadian Wheat Board (CWB) is the sole marketing agent for the domestic food grains market and for the international market for wheat, oats and barley. The CWB pays producers a guaranteed minimum price--which is usually set below world market prices--upon delivery of the grain. If the sales of the Board average out at a price higher than the initial minimum price, the additional proceeds are divided up among producers based on the amount of grain delivered. The result is that all producers receive the same price for their wheat before transportation charges are netted out regardless of the time of year they market their crop.

This type of system raises questions as to what the important variables are in analyzing the response of producers to changing world market conditions. Do producers use the initial delivery price to determine the amount of wheat acreage to plant or do they use some expected discounted total payment from the Canadian Wheat Board? It is also possible that they could use world wheat prices as a proxy for what the final total payment of the Board will be or that they may not respond at all to changes in price or CWB payments as long as their revenue remains within a certain range. (For further discussion of this issue, see Meilke, 1976.)

An important second aspect of the Canadian marketing system is the market quota system which was initiated after a number of successively large harvests raised wheat stocks to unprecedented levels at the end of the 1969/70 season. The Canadian government instituted an "emergency" one year program for the 1970/71 crop year called Operation LIFT (Lower Inventory For Tomorrow) designed to cut wheat acreage in half by paying farmers to put land into summer fallow. Delivery quotas for wheat were

then instituted for the following years but were relaxed when world wheat market conditions tightened and prices rose.

A final aspect of Canadian grain marketing program is the Western Grains Stabilization Program begun in 1976. This program guarantees that ". . . each year the net cash flow to prairie grain producers as a group will not be below the previous five-year average . . ." (Oleson, 1979, p. 4). It is a voluntary program to which producers contribute one-third and the federal government contributes two-thirds of the financing. Given the recent enactment of the Western Grains Stabilization Program, it is difficult to determine the exact impact the program will have on Canadian wheat production. It should not only achieve its stated objective of stabilizing farm income, but it should also stabilize production levels. (For a thorough discussion of Canadian wheat and grain policies, see Oleson, 1979; McCalla and Schmitz, 1979; IWC 1963/64-1976/77 various issues; OECD, 1973b; OECD, 1973c; and Meilke, 1976.)

Supply. The Canadian balance sheet estimates for this study are less sophisticated tham some other recent studies (see MacLauren, 1977, and Lattimore and Zwart, 1978), but the lack of data and the limited marginal value of increased complexity precluded fine tuning the Canadian model. On the supply side wheat production was formulated as a function of the previous year's producer price and a dummy for Operation LIFT. The model was not very satisfactory since the dummy was significant at only the 10 percent level and the price variable was not significant. The direct estimate did not provide very much basis for confidence in future projections.

TABLE XV

BALANCE SHEET EQUATIONS ESTIMATED FOR CANADA

Statistics	Dependent Variables[a]					
	PDNC	YLDC	HHC	FOODC	FEEDC	SEEDC
Intercept	14921	-.862	4368	973	-996	415
Regression Coefficients						
YR		.0363			50.0	
(t)		(2.91)			(3.06)	
DPPLCC	22.3					
(t)	(.73)					
DFO	-7193		-5464			
(t)	(-1.79)		(-7.15)			
LHHC			.607			
(t)			(5.99)			
PCYC				122		
(t)				(10.30)		
DPPLCC					-5.69	
(t)					(-1.99)	
LSEEDC						.59
(t)						(5.10)
D69						-495
(t)						(-5.72)
Mean	16168	1.61	10157	1691	1720	940
R^2	.25	.36	.87	.88	.47	.83
DW	1.28	2.30	1.76	2.61	2.37	2.11

[a]See Appendix A for a definition of variables and their units.

For Canada, production projections were handled better by breaking out the area harvested and yields components and estimating them separately. Wheat area harvested in Canada was determined to be a function of the previous year's wheat area harvested and a dummy for Operation LIFT. The use of the lagged adjustment model to predict wheat area is an indication of the consistency of Canadian grain policies and the ability of the government to insulate wheat producers from wide swings in world markets.

Canadian wheat yields were projected using a simple trend as a proxy for technology. The production estimates generated from the area harvested and yield equations tracks better than the equation which estimates production directly. From a theoretical point of view, it is rather unfortunate that a price variable was not found to be either significant or of the right sign in the area harvested equation, but by providing a measure of stability and uniformity to wheat marketing, Canadian policy has diluted the influence of price.

Demand. On the demand side, the food use of wheat in Canada was defined as a function of per capita income; feed use depended on trend and the deflated producer price of wheat; and seed use responded to changes in the previous year's seed use and a dummy for Operation LIFT.

Oceania

In terms of wheat production and consumption the continent of Oceania is dominated by Australia. New Zealand and the other islands which complete the make up of the continent are of only minor importance

and--for the purposes of this study--are treated as an aggregate called the "Rest of Oceania".

Australia

Policy and Characteristics. Australia is one of the five major wheat exporters of the world. Her exports over the past two decades have generally ranked behind the U. S. and Canada and have been in close competition with France and Argentina for third in total wheat exports.

Most of the area devoted to wheat in Australia is on large farms that also raise sheep or cattle. Although wheat is the most important grain produced, barley, corn and sorghum became increasingly important over the past few years. Wheat is grown primarily in the southeast and southwest parts of the country--areas that are subject to recurrent droughts.

Like Canada, Australia has a wheat marketing board which purchases all wheat destined for national or international commerce. The Australian Wheat Board (AWB) makes an initial payment to farmers soon after receiving the grain. As the board receives proceeds from the sale of wheat in excess of the initial payments it is able to pass along the funds to the growers as additional payments. Each grower receives a return based on the quantity of wheat delivered and the average selling price realized by the AWB for that particular crop. The payments for a particular crop often take years to finalize. (For a more detailed discussion of Australian agricultural policy as it relates to wheat, see OECD, 1973a and OECD, 1973c, pp. 98-102.)

This payment system is coupled with a Wheat Price Stabilization Fund. A guaranteed price is set each year. When the average export

price falls below the guaranteed price, an amount is withdrawn from the Fund to make up the difference. If the export price exceeds the guaranteed price, the surplus is paid into the fund. When the growers' money in the Fund is exhausted (as has been the case over the past 20 years), the government pays into the Fund. In effect, the guaranteed price has operated as a subsidy over most of the study period.

Superimposed on this payment framework is a system of wheat delivery quotas enacted beginning in the 1969/70 crop year. The impetus for this arrangement was a bumper wheat crop in 1968/69 which created serious storage and disposal problems. Even though the quota system has been in effect since the 1969/70 crop year, low prices, low yields and temporary suspensions of the quota have limited its effectiveness. In fact, a study by Fisher concluded in 1975 that, ". . . it would appear that 1970-71 was the only season in which quotas caused wheat planting to fall below the level already established by lower wheat prices . . ." p. 87).

In 1974 the Australian Wheat Growers' Federation adopted a new five year stabilization plan beginning with the 1974/75 season. The same framework as in previous plans was maintained but changes were made to make production more responsive to changes in export prices. (A discussion of the five year stabilization plan beginning in 1974/75 can be found on page 67 of IWC, 1973/74a.)

Supply. The result of this rather complicated Australian wheat marketing structure is that, until recently, Australian producers have not responded very readily to world prices. This is apparent from the area harvested equation in Table XVI. In this equation, the number of

TABLE XVI

BALANCE SHEET EQUATIONS ESTIMATED FOR AUSTRALIA AND THE REST OF OCEANIA

	Dependent Variables[a]							
	Australia						Rest of Oceania	
Statistics	PDNAU	YLDAU	HHAU	FOODAU	FEEDAU	SEEDAU	PDNROC	DUROC
Intercept	-5157	1.23	1882	1029	1077	159	295	395
Regression Coefficients								
YR	217							
(t)	(1.93)							
LHHAU			.76					
(t)			(4.90)					
D70			-2954					
(t)			(-3.35)					
LPPUAU			5.19					
(t)			(.30)					
PCYAU				62.5				
(t)				(3.16)				
RWBARPAU					-56.5			
(t)					(-3.55)			
D656772					369			
(t)					(3.47)			
HHAU						.047		
(t)						(3.66)		

TABLE XVI (Continued)

Statistics	Dependent Variables[a]							
	Australia						Rest of Oceania	
	PDNAU	YLDAU	HHAU	FOODAU	FEEDAU	SEEDAU	PDNROC	DUROC
Mean	9663	1.23	7965	1281	521	527	295	395
R^2	.20		.72	.40	.62	.47		
DW	2.39		2.42	1.79	.81	1.97		

[a]See Appendix A for a definition of variables and their units.

hectares harvested are specified as a function of the previous year's hectares harvested, a dummy for the 1970/71 quota and the previous year's wheat export price. The export price is not significant, but since it is of the right sign and since the Australian government has instituted measures recently to make wheat production more responsive to world prices, it was left in the equation.

Wheat yields in Australia over the study period were so variable that the mean was as accurate as any other prediction. Due to the yield variability, the direct estimation of production resulted in only a weak positive trend.

Production estimates based on area harvested and yields were used instead of the single equation production estimates because the former provided at least some opportunity for policy and prices to have an impact. Yet this should not obscure the fact that yield variability is the single biggest factor affecting Australian wheat supply.

Demand. Australian utilization of wheat is specified as expected given the characteristics of the country and its agriculture. However, one factor that was very perplexing was the variability in Australian food use. Even though the variability is not very great (less than ten percent of the mean), there have been some sharp changes from year to year (e.g., 1965/66 and 1972/73) which suggests changes in the population or varying accounting procedures.

As shown in Table XVI, per capita income was used to explain food use while a ratio of the wheat to the barley price and a dummy for drought years was used to specify the feed use equation. The dummy is used because a large number of Australian wheat producers also raise

sheep. In very bad drought years, wheat stored on-farm may be the only grain available to feed a forage-starved flock. Seed use for Australia was determined to be a function of the area harvested.

Though it appears that Australia's exportable surplus has been gradually expanding since the quota restriction of 1970, Australians have not taken full advantage of the rapid rise in wheat prices in 1972 and 1973. This is partly due to weather conditions but also because of the marketing arrangement and quota restrictions. Had producers been able to receive the income from their crops more quickly (rather than over a two and one-half year period), and had they been able to plant a larger area, Australian wheat production might have been much larger in spite of weather conditions.

Rest of Oceania

For the rest of the continent of Oceania, neither wheat production nor utilization showed any significant trend. Hence, the respective means were used for future projections.

For the continent as a whole, a net surplus condition prevails with respect to wheat. The supply-demand balance for the continent is dominated by Australia which, apart from New Zealand, is the only major country in the region.

CHAPTER IV

BALANCE SHEET PROJECTIONS FOR 1985

The objective of this chapter will be to obtain a reasonable set of wheat supply and demand projections for specified countries and regions of the world for 1985 using the balance sheet regression estimates from Chapter III. The 1985 projections will be presented as two possible long range alternatives. The first will portray the 1985 world wheat economy as an extrapolation of the trends represented in the balance sheet estimates of Chapter III. It will assume that there will be no further major institutional changes which have not already been included in the balance sheet model. Since some of the balance sheet projections are the result of trends which are unlikely to be sustained, a second, more "reasonable" set of conditions is presumed in the baseline predictions of the second alternative. The actual 1985 wheat supplies might deviate from the baseline depending on weather conditions or other short run aberrations in the international wheat market. These aberrations will be presented as two opposing sequences--one which presumes a major crop failure in one or more of the major wheat producing regions of the world and another which posits an extraordinary harvest in one or more of these regions.

Balance Sheet Projections

This section includes 1985 projections that will result when 1985 values are substituted into the balance sheet equations estimated in Chapter III. Since trend and dummy variables were used frequently in the analysis, the 1985 values for independent variables in most cases, were not difficult to obtain. Yet there were a number of occasions when trend or zero-one values were not sufficient. In the case of variables with a strong trend such as population or income, 1985 values were obtained by regressing these variables against trend and using the 1985 projection. For deflated prices and price ratios--variables which have no strong trend--a three or five year average of the end of the study period was used (e.g., for LDWPLIN, an average of the 1974/75-1976/77 crop years was used). The criteria for choosing a five-year versus a three-year average was based on which average appeared to best represent recent events. In general a five year average was used but in cases where the last three years indicated a sharp departure from the values of previous years (LDWPLIN and RWBARAU), the three-year average was used.

There are two major exceptions to the general procedures outlined above. The first concerns the values to be used for the lagged area harvested variables (LHHAU and LHHC) used in the Australian and Canadian area harvested equations (HHAU and HHC). An examination of recent data would indicate that both LHHAU and LHHC have been gradually increasing since 1970. However, if these variables were trended out to 1985, the results would be extremely high wheat acreages for both countries. In 1969 when area harvested approached the level of 12,000 hectares in Canada and 11,000 hectares in Australia and was coupled with

a large accumulation of stocks, delivery quotas and other restrictions were imposed in both countries which brought about sharp cutbacks in production. Therefore a five-year end-of-period average was used for LHHAU and LHHC under the assumption that Canada and Australia would impose restrictions, before they would allow acreages to reach traditionally excessive levels.

The second major exception is in regard to the dummy variables used in projecting the feed use of wheat in EEC countries. It has been assumed in this analysis that dummy variables represent the influence of structural changes which are not expected to change before 1985. One such structural changes occurred in 1973 when world wheat supplies became tight and the EEC discontinued the practice of paying a subsidy--known as the denaturing premium--for the feed use of wheat. This change was accounted for in most European feed use equations through the use of a dummy (D7376) and a dummy slope (DYR7376). In Italy, a dummy and dummy slope were specified for the 1967-1973 period in order to take account of both the beginning of the CAP and the end of the denaturing premium. In 1977, when wheat supplies had returned to more normal levels, the EEC again elected to encourage the feed use of wheat through a scheme which classifed the grain as either a quality or a feed wheat. Feed wheat prices were then set nearly 12 percent below the reference price for quality wheat making soft wheat, for which the EEC is a surplus producer, more competitive with feed grains (see USDA, 1977c, p. 21).

Though the new pricing scheme is not the same as the denaturing premium, the effect is the same. Therefore when feed projections were made for the EEC countries, the dummy which accounted for the discontinued

denaturing premium was assumed to be zero (in the case of Italy, D6773 was again assumed to be one).

The balance sheet projections are summarized in Tables XVII and XVIII. Table XVII gives the actual 1985 projections and Table XVIII gives the percentage change of each of the projected variables from their average level over the last three years of the study period (i.e., 1974/75-1976/77).

It is important to note that the metric ton values in Table XVII are not a totally accurate representation of the absolute level of all of the country and continent wheat uses and supplies. On an aggregate level, it was found that when total world wheat utilization was subtracted from total world production and account was taken for changes in stocks, a positive residual remained which averaged 6.9 million metric tons over the study period. This indicates either a net over-estimation of supply or a net underestimation of total utilization. The evidence appears to favor the latter for two reasons. First, production data on the world level are probably more accurate than utilization data. For a number of countries wheat utilization data do not exist or they have been constructed using population and estimated per capita consumption levels. Wheat production data, on the other hand, are readily available for almost all countries of the world and can now be verified with satellite photographs. Hence, the measurement error is most likely in the utilization statistics.

Second, as shown in the first column of a following table, the "Potential Import Market" for wheat in the 1974-1976 period was 36.9 million metric tons. During this same period, the four major wheat exporters dispatched a total of 52.6 million tons of wheat exports--15.7

TABLE XVII

1985 BALANCE SHEET PROJECTIONS

	Area Harvested	Yield	Pro-duction	Food Use	Feed Use	Seed Use	Dom. Util.	Supply-Demand Balance
	mha	mt/ha	mmt	mmt	mmt	mmt	mmt	mmt
Western Europe Total			64.2[d]				58.2	6.0
Germany	--	--	8.7[d]	3.9	3.3	.3	7.5	1.2
Italy	--	--	8.9[d]	10.2	.8	.6	11.6	-2.7
Netherlands	.1	6.2	.5	1.0	.6	.1	1.7	-1.2
France	4.0	4.8	19.4	4.5	3.1	.6	8.2	11.2
United Kingdom	1.4	4.1	5.8[d]	5.2	2.3	.3	7.9[d]	-2.0
Rest of West Europe	--	--	20.9[d]	--	--	--	21.4[d]	-.5
Africa Total			13.2				25.3	-12.1
Egypt	.6	4.6	2.6[d]	8.4	--	.1	8.5[d]	-5.9
Rest of Africa	--	--	10.6[d]	--	--	--	16.8[d]	-6.2
Asia Total			90.8[d]				101.7	-10.9
India	--	--	45.9[d]	36.0	.5	2.9	39.4	6.5
Japan	--	--	.2[d]	5.2	.6	--	5.8[d]	-5.6
Rest of Asia[a]	--	--	44.7[d]	--	--	--	6.5[d]	-11.8
Latin America Total			12.9				17.1	-4.2
Brazil	5.7	1.5	8.4[d]	4.5	.8	.4	5.7[d]	2.7
Rest of Latin America[b]	--	--	4.5[d]	--	--	--	11.4[d]	-6.9
Rest of Oceania	--	--	.3[d]	--	--	--	.4[d]	-.1

TABLE XVII (Continued)

	Area Harvested	Yield	Pro-duction	Food Use	Feed Use	Seed Use	Dom. Util.	Supply-Demand Balance
	mha	mt/ha	mmt	mmt	mmt	mmt	mmt	mmt
Communist Total			205.7[d]				214.3[d]	-8.6
Eastern Europe	--	--	37.5[d]	--	--	--	39.8[d]	-2.3
USSR	--	--	114.4[d]	--	--	--	124.1[d]	-9.7
PRC	--	--	53.8[d]	--	--	--	50.4[d]	3.4
Subtotal[c]			387.1				417.0[d]	-29.9
Argentina	--	--	8.7[d]	4.4	.3	.7	5.4	3.3
Australia	8.5	1.2	10.5	1.4	.7	.6	2.7	7.8
Canada	9.7	2.2	21.7	2.1	2.5	.9	5.5	16.2
3 Exporters' Total			40.9				13.6	27.33

[a]Excludes People's Republic of China.

[b]Excludes Argentina.

[c]World total less four major exporters.

[d]Estimated as an aggregate.

TABLE XVIII

PERCENTAGE CHANGE IN THE 1985 PROJECTIONS FROM THE AVERAGE OF 1974-1976

	Hectares Harvested	Yield	Pro-duction	Food Use	Feed Use	Seed Use	Dom. Util.	Supply-Demand Balance
			Percentage Change					
Western Europe Total			12				6	122
Germany	--	--	22	3	18	20	9	323
Italy	--	--	-6	12	237	-12	16	-365
Netherlands	-29	16	-18	1	286	209	47	-132
France	-2	18	15	9	6	11	-8	42
United Kingdom	20	-6	13	-1	-27	24	-10	42
Rest of Western Europe	--	--	14	--	--	--	11	44
Africa Total			40				43	-45
Egypt	3	38	34	56	--	1	54	-66
Rest of Africa	--	--	42	--	--	--	37	-30
Asia Total[a]			51				35	29
India	--	--	83	41	81	47	42	335
Japan	--	--	-3	16	3	-25	14	-15
Rest of Asia[a]	--	--	29	--	--	--	33	-52
Latin America Total[b]			84				28	34
Brazil	101	70	260	22	27	72	25	221
Rest of Latin America	--	--	-4	--	--	--	--	-69
Rest of Oceania	--	--	13	--	--	--	10	0

TABLE XVIII (Continued)

	Hectares Harvested	Yield	Pro-duction	Food Use	Feed Use	Seed Use	Dom. Util.	Supply-Demand Balance
			Percentage Change					
Communist Total			38				35	9
Eastern Europe	--	--	40	--	--	--	30	38
USSR	--	--	39	--	--	--	41	-75
PRC	--	--	33	--	--	--	24	1681
Subtotal[c]			36				30	19
Argentina	--	--	2	17	-30	-15	8	-7
Australia	-2	-10	-9	4	4	1	3	-13
Canada	-1	23	22	13	35	-2	18	23
3 Exporters' Total			8				11	6

[a]Excludes People's Republic of China

[b]Excludes Argentina.

[c]World total less four major exporters.

[d]Estimated as an aggregate.

million tons more than the balance sheet totals would indicate was necessary to fill the needs of the rest of the world. Although a part of the discrepancy may be the result of importers' attempts to build up depleted stocks, a large part of the difference has to be attributed to a net understatement of utilization (assuming the relative accuracy of production statistics).

An examination of Table XVII and XVIII brings to light a number of trends in key areas of the world. One way of analyzing these trends is to compare the figures in the right hand column of each of the two tables. In Table XVII this column shows the projected supply demand balance for each of the model countries along with the subcontinent and continent totals. Note that this balance is simply the difference between total production and total utilization. Hence, a negative value indicates a deficit and a positive value indicates an exportable surplus. In Table XVIII, the right hand column shows the percentage change in the production demand balance from the 1974-1976 average to the 1985 projection. For the importing countries as a whole, the balance sheet projections indicate that the need to import wheat will decline by 19 percent by 1985. In general this results from projected production increases which are greater than projected demand increases. Four countries are primarily responsible for the shrinking market for wheat imports: France, India, Brazil, and the People's Republic of China.

In Western Europe, French wheat production increased only 15 percent, but with the continent's slower growth rate in wheat demand, this increase moved Western Europe from a marginal surplus position to a level of a large exportable surplus. Given the continuation of the current structure

of the Common Agricultural Policy, by 1985 France may be looking beyond its traditional regional markets for a place to sell its wheat.

Of all the countries specified in the model, Brazil and India show the most dramatic increases in projected wheat production over the next few years. Brazil's production is forecast to increase by 260 percent and India's by 83 percent. Both countries are shown to move from a position of a net deficit to one of an exportable surplus which, altogether, would be an increase of 9.2 million metric tons of wheat for sale on the world market.

Finally, a look at the projections for the People's Republic of China reveals a somewhat similar situation. China, in the 1974-1976 period, had reached a level of self sufficiency in wheat. By 1985 Table XVII shows the Chinese to have a substantial exportable surplus.

In contrast, the production increases on the import side of the market are not projected on the export side.[1] Together, the three major exporters are projected to have an increase in exportable surplus of only six percent. In fact, both Argentia and Australia are shown to have slight decreases while Canada has an increase in wheat available for export of 23 percent.

Baseline Projections

A few alterations were made in the balance sheet forecasts to obtain a set of baseline projections which would present a more conservative and,

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[1]This is, in part, due to the method mentioned earlier that was used to determine the values of the independent variables in the Australian and Canadian areas harvested equations. The projections implicitly assume a policy response by Canada and Australia to avoid a build up in their respective wheat stocks.

perhaps, a more realistic forecast of future production increases in a few of the more important importing countries. The supply-demand balance for these projections is shown in Table XIX along with the supply-demand balance of the balance sheet projections and the average balance for the 1974-1976 period. As is evident from the table, the difference between the first and the second alternative is that the former assumes, given current trends and prices, that each of these three countries--India, Brazil and the People's Republic of China--will have a substantial exportable surplus by 1985 while the premise of the latter is that there are factors in each of these countries which were unobserved or unmeasured in the 1960-1976 time period which will deter these countries from reaching the surplus levels forecast in the first alternative.

For India, self-sufficiency in grains has been a national goal for 30 years but it was not until 1968 when new irrigation techniques and higher yielding wheat varieties were introduced that this became an achievable goal. Though India may be capable of becoming self-sufficient or even an exporter of wheat by 1985, government policy appears to be directed at maintaining adequate domestic stocks to lessen the strain on food supplies during years of poor harvest (see Sarma, 1978). It therefore appears likely that upon reaching self-sufficiency in grains, India may choose to divert resources to other areas of agriculture and the economy.

In view of the Brazil's rapid entry into the international soybean market during the past decade, the assumption that Brazil will not become a wheat exporter by 1985 seems rather tenuous. Yet the 260 percent increase in Brazilian wheat production predicted for 1985 by the balance

TABLE XIX

1985 ALTERNATIVE LONG RUN PROJECTIONS OF WORLD WHEAT AVAILABILITIES

	1974-76	1985 Projections			
		Balance Sheet Projections		Baseline Projections	
	Supply-Demand Balance	Supply-Demand Balance	Percent[d] Change	Supply-Demand Balance	Percent[d] Change
	mmt	mmt	%	mmt	%
Western Europe, Africa and Rest of Oceania	-5.8	-6.2	-7	-6.2	-7
Asia Total[a]	-15.3	-10.9	29	-17.4	-14
India	-2.7	6.5	335	0	100
Latin America Total[b]	-2.2	-4.2	34	-6.9	-10
Brazil	-6.3	2.7	221	0	100
Communist Total	-9.4	-8.5	9	-11.9	-27
Eastern Europe	-3.7	-2.3	38	-2.3	38
Soviet Union	-5.5	-9.6	-75	-9.6	-75
People's Republic of China	-.2	3.4	1681	0	100
Potential Import Market	-36.9	-29.9	19	-42.4	-15
3 Exporters' Total[f]	25.6	27.3	6	27.3	6

[a]Excludes People's Republic of China.

[b]Excludes Argentina.

[c]World total less four major exporters.

[d]Estimated as an aggregate.

[e]A negative sign indicates an increase in demand relative to production.

[f]Argentina, Australia, and Canada.

sheet equations appears to be far too rapid. This rapid an increase would require a substantial effort by the Brazilian government to expand acreage and improve yields (which are some of the lowest in the world)--an effort which has not yet been forthcoming.

For China, the goals of the ten-year economic plan ending in 1985 are even more ambitious than the already optimistic forecasts of the balance sheet projections. The plan calls for grain production of 400 million tons by 1985--43 percent above the 1977 level (see USDA, 1978). If wheat production were to increase by this amount, it would be 3.4 million tons above the projected amount in Table XVII.

For a number of reasons, the Chinese may find it difficult to attain this goal or even reach self sufficiency by 1985. Writing in the Agricultural Situation of the People's Republic of China, Liu (1978, p. 8) points out that, ". . . the ten-year economic plan calls for rapid growth in every sector in the economy. Each part of the whole scheme requires massive infusions of capital, resources, manpower and modern technology . . ." He adds that China will be faced with the problem of rationing extremely scarce resources among competing sectors and that, ". . . the prospects for a significant take-off of Chinese (agricultural) exports are not good . . ."

Even if China could significantly increase its production of wheat, the International Wheat Council stated recently that it is unlikely that Chinese imports of wheat will be discontinued in the near future.

> . . . The reasons for this is that China has no integrated market for cereals . . . To move wheat overland would be very costly and present logistical difficulties. This situation is unlikely to change in the near future because the Chinese Government has decided to give priority to electricity to encourage rural development, instead of transport which would have required more investment . . . (IWC, 1976/77a, p. 85).

The baseline projections assume, therefore, that India, Brazil and China are each able to achieve self-sufficiency in wheat by 1985 but are not likely to become major exporters. Given self-sufficiency in each of these three countries along with the continuation of current trends and prices in the rest of the world, the baseline projections in Table XIX show a supply-demand balance subtotal for the world less the four major exporters to be a -42.4 million metric tons--a 15 percent decrease from the average level of 1974-1976. In contrast to the first balance sheet forecasts, these projections point to an increasing market for wheat through 1985 for the four major exporters.

Though the baseline projections represent a reasonable expectation of the international wheat market in an average year for 1985, the actual state of the market can vary substantially due to a change in weather in one or more important wheat producing countries. Hence, two possible sets of weather conditions are postulated for 1985. They are depicted in Scenarios I and II representing very unfavorable and very favorable production conditions respectively. These two scenarios mark the lower and upper limits of the deviations from the long run trends embodied in the baseline forecasts.

Baseline Projections with Abnormal Production

Scenario I: Unfavorable Production Conditions

In 1975 a dry autumn and winter followed by an extremely hot dry summer caused the USSR to suffer a crop shortfall that was 28.5 million tons below the predicted level of 94.7 million tons. Severe weather conditions in other parts of the world also resulted in short crops in

Eastern and Western Europe, Canada, India and Africa. For the world in the year 1975, wheat production was more than 34 million tons below the level of the aggregated balance sheet predictions.

Scenario I, therefore, postulates a 33 million ton shortfall for the 1985 world wheat crop. Table XX shows this shortfall as being concentrated in the USSR, Eastern Europe, and one or more of the three exporters. Though the geographic areas chosen to experience the shortfall were selected primarily for illustrative purposes, there is an historical precedent to justify their selection. Note that the effect of this extremely poor crop in Scenario I is an increase in the absolute level of the import market potential from 42.4 to 72.4 million tons--an increase of 71 percent over the baseline projection.

Scenario II: Very Favorable Production Conditions

In contrast to 1975, there were also some very good harvests--due to favorable weather conditions during the study period. The largest of these was the 1966 crop year when production was over 25 million tons greater than the aggregated balance sheet predictions. Again the Soviet Union was the major contributor with a crop that was 23 million tons greater than predicted. Other countries with large crops included Canada and Australia.

Based on these historical data, Scenario II posits a long crop for the USSR of 21 million tons and similarly favorable crops for one or more of the three importers of four million tons. The result is a decrease in the absolute size of the potential import market of 50 percent from a base of 42.4 to a level of 21.4 million tons. In addition

TABLE XX

POSSIBLE SHORT RUN VARIATIONS IN 1985 WORLD WHEAT AVAILABILITIES

	1985 Projections		
	Baseline	Scenario I	Scenario II
	Supply-Demand Balance	Supply-Demand Balance	Supply-Demand Balance
	mmt	mmt	mmt
Western Europe, Africa, Asia, Latin America, and Rest of Oceania[a]	-30.5	-30.5	-30.5
Communist Total	-11.9	-41.9	9.1
Eastern Europe	-2.3	-5.3	-2.3
Soviet Union	-9.6	-36.6	11.4
People's Republic of China	0	0	0
Potential Import Market	-42.4	-72.4	-21.4
3 Exporters' Total[b]	27.3	24.3	31.3

[a]Excludes People's Republic of China and Argentina.

[b]Argentina, Australia, and Canada.

to the smaller import market, there is a 15 percent increase in the amount available for export in the three exporting countries resulting in a relative glut of wheat on world markets.

The Impact on the U. S. Wheat Export Market in 1985

Up to this point this chapter has focused on projections of the 1975 world wheat market excluding the United States. Two alternative sets of long range trends have been discussed with the most reasonable alternative being designated as a set of baseline projections. Next the upper and lower short term limits of the deviations from these baseline projections were illustrated in Scenarios I and II. Now two further suppositions will be made about the international wheat market in 1985, but, unlike the earlier discussion, these will deal with the structure of the export market rather than with the level of aggregate import demand and will thereby posit two different conditions under which the U. S. may participate in the world wheat market.

The first supposition, Situation 1, assumes that in a world market of four major exporters, the United States is the residual supplier. An alternative market structure, Situation 2, posits a constant market share division of the world wheat market based on 1974-1976 average shares in which the United States maintained a 54.65 percent share and the other three exporters jointly controlled 45.35 percent of the market. Table XXI shows the level of exports for the United States and the three other exporters taken as a group under each of the two long term alternatives and each of the two short term scenarios. The total level of exports for all four exporters is shown on the first line of the

TABLE XXI

U. S. EXPORTS UNDER ALTERNATIVE MARKET SHARE ASSUMPTIONS FOR DIFFERENT 1985 PROJECTIONS

		Balance Sheet		Baseline		Scenario I		Scenario II	
	1974-76 Average	Projected	Change from 1974-76	Projected	Change from 1974-76	Projected	Change from 1974-76	Projected	Change from 1974-76
Adjusted Total Imported Demand	48.9	41.9	-7.0	54.4	5.5	84.4	35.5	33.4	-15.5
Situation 1: U.S. as Residual Supplier	Projected Exports	Projected Exports	Change from 1974-76	Projected Exports	Change from 1974-76	Projected Exports	Change from 1974-76	Projected Exports	Change from 1974-76
Three Exporters[a]	25.6	27.3	1.7	27.3	1.7	24.3	-1.3	31.3	-5.7
United States	23.3	14.6	-8.7	27.1	3.8	60.1[b]	36.8	2.1[c]	-21.2
Situation 2: Constant Market Shares									
Three Exporters[a] (45.35%)	22.2	18.9	-3.3	24.7	2.5	38.3[b]	16.1	15.1[c]	-7.1
United States (54.65%)	26.7	23.0	-3.7	29.7	3.0	46.1[b]	19.4	18.3[c]	-8.4

[a]Argentina, Australia, and Canada.

[b]The maximum quantity of exports during the 1960-76 period for the U. S. was 32.0 million metric tons and for the other three major exporters was 26.9 million tons.

[c]Though more wheat would be available for export, the Adjusted Total Import Demand is for only 20.9 million metric tons.

table as the "Adjusted Total Import Demand". This adjusted total demand is equal to the absolute value of the "Potential Import Market" entries in Tables XVII, XIX, and XX plus the estimated average understatement of world wheat utilization for the 1974-1976 period (approximately 12 million tons). The table shows that when the U. S. is strictly a residual supplier, projected U. S. exports can vary from a high of 60.1 million tons in Scenario I to a low of 2.1 million tons in Scenario II. Under this structure, the other three exporters are able to sell all the wheat they have available for export which means that their exports vary only with their own levels of production and utilization.

The second structure, which assumes constant market shares, results in each of the four exporters bearing an equal share of the variation in the total import demand. Under this structure, the respective exports of the U. S. and three other exporters in a year of poor world harvests would be 46.1 and 38.3 million tons. If 1985 is a year of good harvests, the U. S. and the three other exports will sell only 18.3 and 15.1 million tons of wheat respectively on the world market. Clearly, the constant market share structure results in less variation in U. S. exports and a greater variation in the exports of the other three exporters relative to the first structure in which the U. S. is a residual supplier.

It is worth noting that Scenarios I and II represent relatively short term extreme situations that would occur only once every 15 or 20 years. Yet these extremes, as shown in Table XXI, would severely tax the four major exporters' export capacity in the case of Scenario I and their storage capacity in Scenario II. Fortunately, there are three

factors which should confine the variation in exports to something less than the extreme limits given in Table XXI.

First, the development and dissemination of better cultivation techniques--particularly the increase in the use of fertilizers and irrigated acreage--should result in relatively more stable future production levels. Second, inventories of wheat will continue to play an important role in spreading abundance and scarcity over a number of years. Finally, the price system will provide signals to both producers and consumers as to the adjustments that need to be made.

The methodology of this chapter has been one of comparative statistics. Constant prices have been assumed in order to concentrate the influence of technological trends, changes in weather and alternative market structures upon international wheat trade in 1985. In Chapter V, a more dynamic view of the world wheat market will be presented in which the sharp broad swings in export demand which were determined in this chapter in the absence of price changes will be diminished through the interaction of prices and quantities.

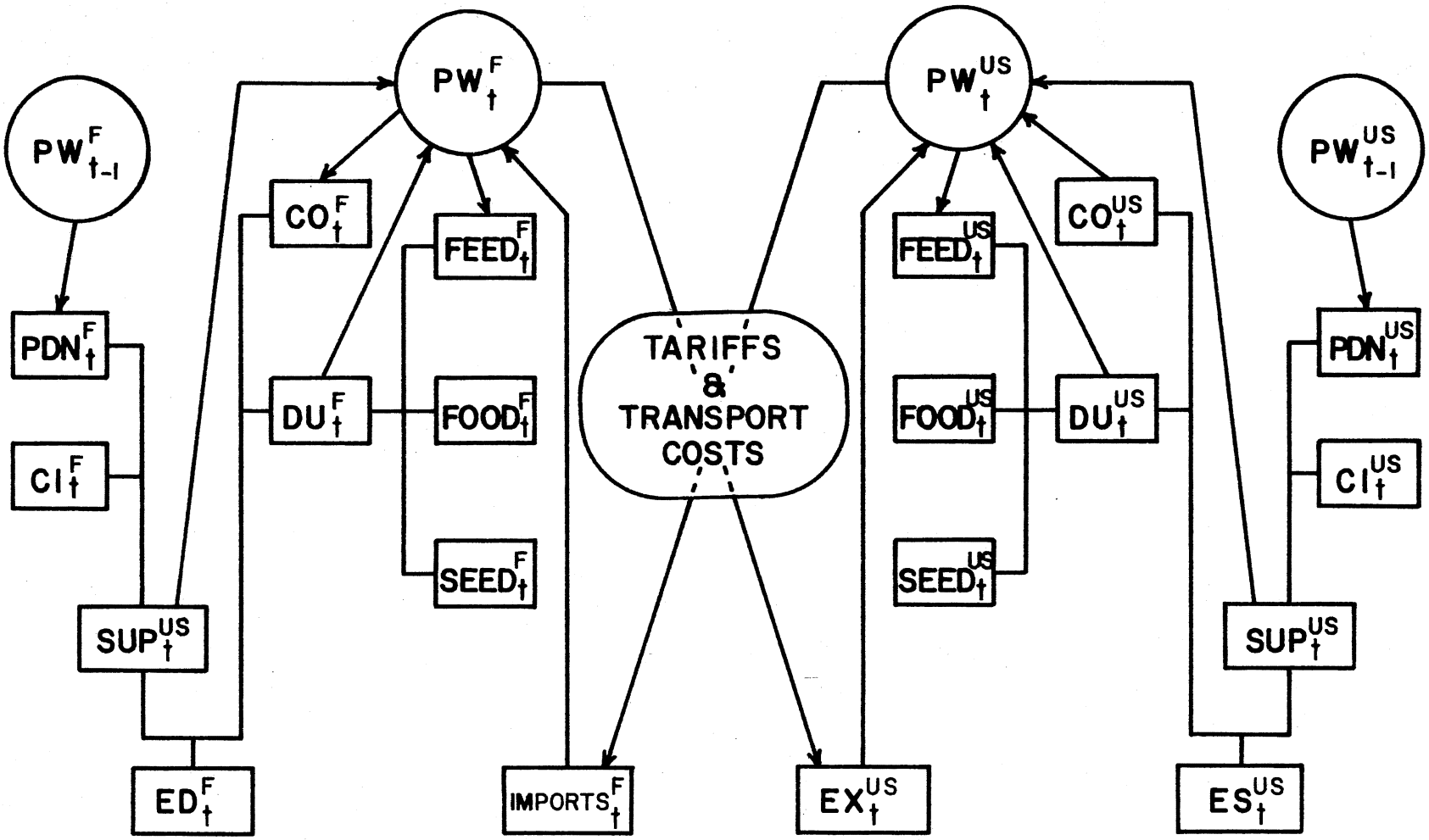
CHAPTER V

AN ECONOMETRIC MODEL OF THE UNITED STATES IN THE WORLD WHEAT MARKET

In the last chapter, constant average 1972-1976 prices were assumed in developing two sets of long range forecasts of the level demand for U. S. wheat exports in 1985. It was discovered, however, that variations in the weather in a few key wheat producing countries could dramatically shift the level of export demand. In this chapter, a simultaneous equation model of demand and supply of U. S. exports will be used to show how the export variation identified in Chapter IV will be mitigated as market forces respond to changes in price.

The Theoretical Model

The structure of the econometric model to be estimated in this chapter is shown in Figure 6. Note that it is a simple interregional trade model [as shown in Figure 1 in Chapter II] for which the world less the United States comprises the import or excess demand sector with the United States making up the export or excess supply sector. A theoretical mathematical model can be constructed using the relationships depicted in Figure 6. This econometric model can be divided into two sections--a recursive block and a simultaneous block. The equations in the recursive block will be estimated independently with ordinary least squares and will represent relationships among predetermined



*Terms are defined in Table XXII.

Figure 6. A Flow Chart of Trade between the Wheat Economy of the United States and the Wheat Economy of the Rest of the World

variables which are required for the solution of the whole system but are not affected by that solution in the current period. The set of equations in the simultaneous block represent interdependent relationships for which a simultaneous estimation method must be used.

For this model, the equations for production, food use and seed use of wheat are included in the recursive block. These variables are required in the solution of excess supply and excess demand but they are not themselves affected by that solution in the current period. The mathematical specification of these relationships is as follows:

$$PD_t^F = \beta_{10} + \beta_{11} PW_{t-1}^F + \beta_{12} YLD_t^F$$

$$PD_t^{US} = \beta_{20} + \beta_{21} PW_{t-1}^{US} + \beta_{22} YR$$

$$FO_t^{US} = \beta_{30} + \beta_{31} Y_t^{US}$$

$$SE_t^{US} = \beta_{40} + \beta_{41} HPL_t^{US}$$

where the "F" superscript denotes the "foreign" sector which includes the total for the world excluding the United States and the "US" superscript refers to United States' variables. The "t" subscripts refer to the time period of the variable. A list of all the variables used in this model is given in Table XXII along with their definitions and their classification within the model as either endogenous or predetermined. All of the signs of the coefficients in the recursive block are expected to be positive except for the coefficient on income (Y_t) in the United States' food use equation (FO_t^{US}). The coefficient, β_{31}, can have either a positive or negative sign depending on whether wheat is a normal or an inferior good in the United States.

Theoretically, equations for food and seed use for the foreign sector should also be included in the recursive block, but the lack of

TABLE XXII

LISTING, CLASSIFICATION AND DEFINITION OF SIMULTANEOUS EQUATION MODEL VARIABLES

Variable	Definition
	Endogenous Variables
DU_t^F	Domestic consumption of wheat for the world less the United States in 1000 metric tons in crop year t.
CO_t^F	Wheat carry-out stocks for the world less the United States in 1000 metric tons in crop year t.
FE_t^{US}	Feed use of wheat in the United States in 1000 metric tons in crop year t.
CO_t^{US}	Wheat carry-out stocks in the United States in 1000 metric tons in crop year t.
PW_t^{US}	Season average wheat price in the United States in dollars per bushel in crop year t.
PW_t^F	Season average import price of wheat in the United Kingdom in dollars per metric ton in crop year t.
EX_t^{US}	United States wheat exports in 1000 metric tons in crop year t.
	Predetermined Variables
PD_t^F	Wheat production for the world less the United States in 1000 metric tons in crop year t.
PD_t^{US}	Wheat production in the United States in 1000 metric tons in crop year t.
FO_t^{US}	Food use of wheat for the United States in 1000 metric tons in crop year t.
SE_t^{US}	Seed use of wheat for the United States in 1000 metric tons in crop year t.
YLD_t^F	Average wheat yields for the world excluding China in metric tons per hectare in crop year t.
YR	Trend, equals the last two digits of the year.
Y_t	Per capita disposable income in the United States in calendar year t.

TABLE XXII (Continued)

Variable	Definition
APL_t^{US}	Wheat area planted in the United States in 1000 hectares in crop year t.
$POPW_t$	World population in millions of people in calendar year t.
CI_t^F	Equal to CO_{t-1}^F.
LVN_t^{US}	Grain consuming animal units in the United States in 1000 units in the year beginning October 1.
PC_t^{US}	A weighted average price of competitive feed grains (barley, corn and sorghum) in the United States in dollars per bushel in crop year t).
CI_t^{US}	Equal to CO_{t-1}^{US}.
DU_t^{US}	Total domestic demand for wheat in the United States in 1000 metric tons in crop year t.
PW_{t-1}^F	Season average import price of wheat for the United Kingdom in dollars per ton in crop year t-1.
PW_{t-1}^{US}	Season average wheat price in the United States in dollars per bushel in crop year t-1.

a complete wheat usage breakdown on the world level meant that a total domestic utilization relationship had to be used instead. This equation appears in the simultaneous block.

The simultaneous block is a set of equations for which the values of seven interdependent endogenous variables are solved simultaneously. This block can be specified with five stochastic equations and two identities.

$$DU_t^F = \alpha_{51} PW_t^F + \beta_{50} + \beta_{51} POPW_t$$

$$CO_t^F = \alpha_{61} PW_t^F + \beta_{60} + \beta_{61} CI_t^F + \beta_{62} PD_t^F$$

$$FE_t^{US} = \alpha_{71} PW_t^{US} + \beta_{70} + \beta_{71} LVN^{US} + \beta_{72} PC_t^{US}$$

$$CO_t^{US} = \alpha_{81} PW_t^{US} + \beta_{80} + \beta_{81} CI_t^{US} + \beta_{82} PD_t^{US}$$

$$PW_t^{US} = \alpha_{91} PW_t^F + \beta_{90}$$

$$EX_t^{US} = DU_t^F + CO_t^F - PD_t^F - CI_t^F$$

$$DU_t^{US} = FO_t^{US} + FE_t^{US} + SE_t^{US} + CO_t^{US}$$

In the first four equations, the expected sign on the price coefficients should be negative since these are all demand relationships. The remaining independent variables are expected to have positive signs with the exception of carry-in stocks (CI_t^F and CI_t^{US}) in the foreign and U. S. carry-out equations. In these equations carry-in could have either a positive or a negative sign depending on whether beginning stocks followed a steady trend or were cyclical from year to year.

The Estimation Results

As indicated, the model was estimated in two sections. Estimates for the recursive block were obtained using ordinary least squares and

the values for the simultaneous block were the result of using a two stage least squares procedure. The results for both blocks are given below with the students' t statistic in parentheses below the appropriate variable and the multiple correlation coefficient and the Durbin-Watson statistic to the right of the estimated equation when they are appropriate.

Recursive Block:

$$PD_t^F = -51624 + \underset{(1.24)}{61.9\ PW_{t-1}^F} + \underset{(18.39)}{214981\ YLD_t^F} \qquad R^2 = .97,\ DW = .80$$

$$PD_t^{US} = -54897 + \underset{(2.97)}{2713\ PW_{t-1}^{US}} + \underset{(7.12)}{1322\ YR} \qquad R^2 = .90,\ DW = 1.93$$

$$FO_t^{US} = 12599 + \underset{(7.98)}{.49Y_t^{US}} \qquad R^2 = .81,\ DW = 1.18$$

$$SE_t^{US} = -33.52 + \underset{(5.35)}{.081\ APL_t^{US}} \qquad R^2 = .66,\ DW = 1.74$$

Simultaneous Block:

$$DU_t^F = -205419 - \underset{(-2.24)}{182\ PW_t^F} + \underset{(12.40)}{144\ POPW_t}$$

$$CO_t^F = 7067 - \underset{(-1.19)}{52\ PW_t^F} + \underset{(1.86)}{.47\ CI_t^F} + \underset{(1.49)}{.076\ PD_t^F}$$

$$FE_t^{US} = -34177 - \underset{(-3.05)}{3325\ PW_t^{US}} + \underset{(3.80)}{.47\ LVN_t^{US}} + \underset{(3.32)}{6893\ PC_t^{US}}$$

$$CO_t^{US} = -26339 - \underset{(-1.52)}{2679\ PW_t^{US}} + \underset{(5.09)}{1.06\ CI_t^{US}} + \underset{(2.19)}{.74\ PD_t^{US}}$$

$$PW_t^{US} = .0456 + \underset{(13.74)}{.0199\ PW_t^F}$$

Although all the sizes for the estimated coefficients in the model meet expectations based on economic theory, a few of the coefficients are not different from zero at the ten percent level of significance.

These included the coefficient on PW^{F}_{t-1} in the foreign production equation, the coefficients on PW^{F}_{t} and PD^{F}_{t} in the foreign carry-out relationship, and the PW^{US}_{t} coefficient in the U. S. carry-out equation. These variables were kept in the model because their presence was theoretically sound and because they were extremely desireable in maintaining the simultaneity of the model.

Elasticities

In order to obtain an idea of the interaction of prices and quantities in this model, a set of elasticities was derived using the appropriate coefficients and the variable means given in Appendix C. They are reported in Table XXIII along with similar elasticities from selected other studies. For this model, most of the price elasticities tend to have an absolute value less than one for both demand and supply. There are two notable exceptions. The first is the elasticity of wheat demand for feed use which has an elasticity of -2.41. Since feed use makes up less than ten percent of the demand for wheat for all purposes in the United States, this figure has relatively little impact on the responsiveness of total American wheat demand to a change in price. Hence, the price elasticity of domestic demand for wheat for all uses is only -.31.

A second important exception is the price elasticity of demand for American wheat exports. United States' wheat exports are shown to be slightly greater than unit elastic (-1.05). As shown in Table XXIII, there seems to be substantial disagreement in the literature over the price elasticity of American wheat exports. Gallegher et al. (1978) estimated an elasticity of only -.41 given the current restrictive

TABLE XXIII

A COMPARISON OF MODEL ELASTICITIES WITH THOSE OF PREVIOUS STUDIES

Elasticity of:	With Respect to:	Elasticity	Similar Elasticities from Other Studies	Source	Time Period and Comments
PD^{US}	PW^{US}_{t-1}	.12	.13	Gallagher, et al., 1978	1952-1974
			.06	Lattimore and Zwart, 1978	1950-1976
FE^{US}	PW^{US}_{t}	-2.41	-3.29	Gallagher, et al., 1978	
			-1.71	Mo, 1970	
			-1.86	Lattimore and Zwart, 1978	
CO^{US}	PW^{US}_{t}	-.26	-1.70	Gallagher, et al., 1978	1956-1974. Privately owned stocks.
			-.38	Zwart and Lattimore, 1977	1950-1976. Total stocks.
			-.57	Lattimore and Zwart, 1978	1950-1976. Government stocks.
			-1.26	Lattimore and Zwart, 1978	1950-1976. Privately owned stocks.
FO^{US}_{t}	Y_{t}	.11	-.31	Gallagher, et al., 1978	1952-1974
			.35	Hutchison, et al., 1970	1950-1970
			-.35	Schmitz and Bawden, 1973	1950-1962
PD^{F}	PW^{F}_{t-1}	.022	.09	Zwart and Lattimore, 1977	Average of selected country and region elasticities.
CO^{F}_{t}	PW^{F}_{t}	-.13	-.15	Zwart and Lattimore, 1977	Average of stock elasticities of other four major exporters.
DU^{F}_{t}	PW^{F}_{t}	-.06		Not available or not comparable.	

TABLE XXIII (Continued)

Elasticity of:	With Respect to:	Elasticity	Similar Elasticities from Other Studies	Source	Time Period and Comments
EX_t^{US}	PW_t^F	-1.05	-.71	Gallagher, et al., 1979	1960-1974. Only for LDC's.
			-.41	Gallagher, et al., 1978	1956-1974
			-6.72	P.R. Johnson, 1977	Assumes very high internal price elasticities.

trade policies in the EEC and Japan whereas P. R. Johnson (1977, p. 736) calculated an excess demand elasticity for U. S. exports of -6.72. A major part of the discrepancy lies in the assumptions regarding supply and demand elasticities for individual countries and regions of the world. Johnson assumes supply and demand elasticities that are three to ten times greater than those generated above. In fact, using the elasticities from this model in Johnson's formula yields an elasticity of excess demand for U. S. exports of only -1.03.

Long Run Equilibrium for the 1976 World Wheat Market

The trade model developed above can be collapsed into a set of wheat price and quantity relationships which can be used to derive a long run equilibrium for the system. This long run equilibrium will be the point of departure for analyzing the response of the American and world wheat markets to changes in supply and demand. The results will provide insights into the potential variation of prices and quantities of wheat for a given shift in supply or demand.

The trade model estimated above can be reduced to price and quantity relationships by substituting the 1976 values (listed in Appendix C) for all the predetermined variables in the system except for the lagged U. S. and foreign wheat prices (PW^{US}_{t-1} and PW^{F}_{t-1}). The result is the following set of equations and constant quantities for 1976:

U. S. Supply:

$$PD^{US}_{t} = 45575 + 2713\ PW^{US}_{t-1}$$

$$CI^{US}_{t} = 18100$$

U. S. Demand:

$$CO_t^{US} = 33699 - 2679\ PW^{US}$$

$$FE_t^{US} = 13154 - 3325\ PW_t^{US}$$

$$FO_t^{US} = 15299$$

$$SE_t^{US} = 2599$$

Foreign Supply:

$$PD^F = 339641 + 61.9\ PW_{t-1}^F$$

$$CI^F = 44300$$

Foreign Demand:

$$CO_t^F = 54561 - 52\ PW_t^F$$

$$DU^F = 385557 - 182\ PW_t^F$$

These equations can be aggregated into one supply and one demand relationship for both the U. S. and the foreign sectors.

If this model has been correctly specified and accurately measured, the excess supply of the United States should equal the excess demand of the rest of the world which should equal the level of American wheat exports--all at 1976 prices. When 1976 prices (see Appendix C) were substituted into the excess supply function for the United States, excess supply was determined to be 25.7 million metric tons. This compares favorably with actual U. S. wheat exports that year of 26.4 million tons. Following the same procedure for the rest of the world, excess demand at prevailing world prices was found to be only 10.9 million tons. Though this figure is far below the actual level of wheat imports from the United States, it is consistent with the balance sheet results of the previous chapter where it was determined that world domestic utilization of wheat had been understated. To compensate for

this measurement error, the amount by which foreign estimated excess demand differs from U. S. exports--14747 thousand tons--is added to the intercept term of the equation for foreign domestic utilization (DU_t^F).

With this adjustment, a system of equations has been constructed which will provide a simple but reasonably realistic model of American wheat trade with the rest of the world. A major drawback of this model is that its solution, in general, represents only a short run equilibrium. In order to be able to analyze the impact of shifts in supply and/or demand schedules on wheat prices and exports, a long run equilibrium is desireable. Without it, the magnitude and even the direction of change that results from a given shift in supply or demand may be obscured by underlying market forces which are causing short run equilibrium values to gravitate toward an unknown long run equilibrium.

Short run equilibrium exists when the quantity supplied equals the quantity demanded at the prevailing market price for a given time period. Long run equilibrium further requires, ceteris paribus, that the quantity supplied equal the quantity demanded at the same market price in future periods (i.e. there is no desire or opportunity to move away from the established equilibrium prices and quantities). For the current model, this means that the price of wheat in the previous year (W_{t-1}) must equal the price of wheat in the current year (PW_t). In addition, because prices are assumed to remain constant over time, there should be no incentive to build or deplete stocks. Hence, in long run equilibrium beginning and ending stocks must be equal.

It is in this latter regard that adjustments need to be made. Since the large Russian wheat purchase of 1972, the United States and

the world have been rebuilding depleted stocks. In the model, projected U. S. carry-out at 1976 prices is 26 million metric tons--eight million tons greater than carry-in stocks. Similarly, world carry-out stocks, in 1976 were 47 million tons at prevailing prices compared with a carry-in of only 44.3 million tons. For long run equilibrium to exist, the carry-out equations must be adjusted so that they will be equal to the corresponding carry-in stocks at the long run equilibrium price.

Since the long run equilibrium price is not known, both it and the carry-out equations must be determined in an iterative process. The first step in this process was to set carry-in stocks for the U. S. and the rest of the world at their mean values of 21.0 and 43.2 million tons. The intercepts on the carry-out equations are then adjusted downward so that, at 1976 prices, ending stocks will be equal to beginning stocks. The adjusted carry-out equations are:

$$CO^{US} = 28.6 - 2.7\ PW_t^{US}$$

and

$$CO^{F} = 50.7 - .052\ PW_t^{F}$$

The adjustment of these equations and of the carry-in stocks, of course, results in a shift of the corresponding aggregated demand and supply equation intercepts.

Given these new demand and supply equations, it is possible to solve for a long run equilibrium by deleting the time subscripts on the wheat prices and setting United States' excess supply equal to the excess demand of the rest of the world.

$$ES_{EQ}^{US} = ED_{EQ}^{F}$$

$$6.9 + 8.7\ PW^{US} = 68.2 - .296\ PW^{F}$$

Substituting in

$$PW^{US} = .0456 + .0199\ PW^{F},$$

the system can be solved for a set of equilibrium prices.

Since these prices still result in an accumulation of stocks, the intercepts of the two carry-out equations are again adjusted downward by the rate of stock accumulation and a new set of excess supply and excess demand equations are solved for the equilibrium prices of $126.78/mt. at the world level and $2.57/bu. for the U. S. Since the results of this second iteration are very close to achieving a constant level of stocks, the equation intercepts are assumed to be at their long run equilibrium levels.

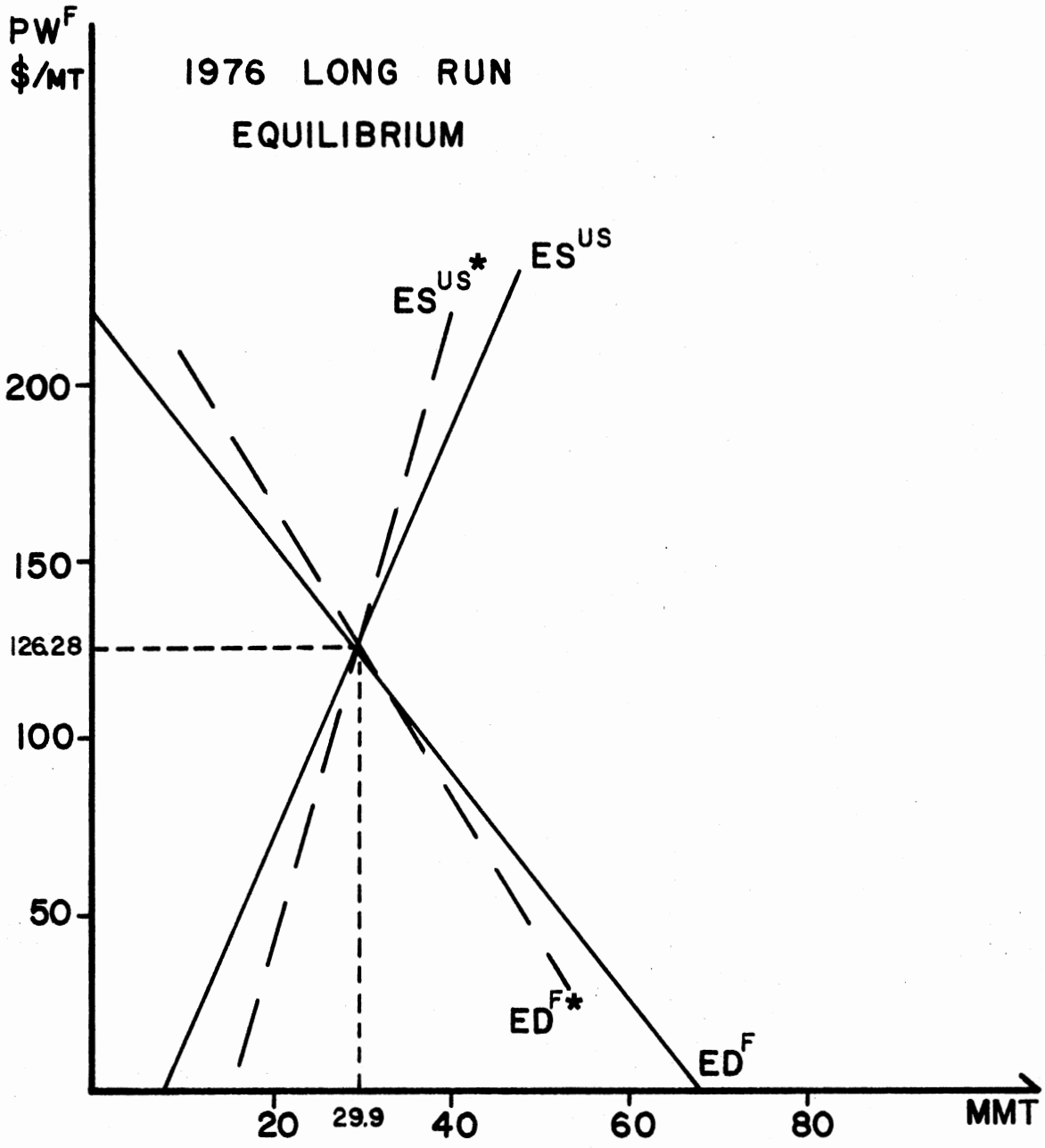
The supply, demand, carry-out, excess supply and excess demand equations for long run equilibrium are given in Table XXIV below and a graph of the equilibrium solution is shown in Figure 7. Observe that the one year excess supply and excess demand curves in Figure 7 are less elastic than their long run counterparts. This is because supply in the short run is assumed to be fixed at its equilibrium value. Therefore, any change in quantity in the short run will have to be made along the U. S. and foreign aggregate wheat demand schedules. In the long run, changes in both the quantity supplied and the quantity demanded will occur accounting for the greater elasticity of the long run functions.

The long run equilibrium shown in Figure 7 as depicted by the equations in Table XXIV may never be observed in reality and may not be at precisely the right level. Yet it is still extremely valuable as a benchmark against which shifts in supply and demand can be measured and a starting point from which the dynamics of the international wheat market can be observed.

TABLE XXIV

1976 ORIGINAL AND LONG RUN EQUILIBRIUM EQUATIONS

Dependent Variable	1976 Original Equations					1976 Long Run Equilibrium Equations		
	Intercept	PW^{U}_{t-1}	PW^{US}_{t}	PW^{F}_{t-1}	PW^{F}_{t}	Intercept	PW^{US}	PW^{F}
SUP^{US}	63.7	2.7				66.6	2.7	
CI^{US}	18.1					21.0		
PD^{US}	45.6	2.7				45.6	2.7	
DMD^{US}	64.8		-6.0			59.0	-6.0	
FO^{US}	15.3					15.3		
SE^{US}	2.6					2.6		
FE^{US}	13.2		-3.3			13.2	-3.3	
CO^{US}	33.7		-2.7			28.0	-2.7	
ES^{US}	-1.1	2.7	6.0			7.5	8.7	
SUP^{F}	383.9			.062		382.8		.062
CI^{F}	44.3					43.2		
PD^{F}	339.6			.062		339.6		.062
DMD^{F}	440.1				-.234	450.3		-.234
CO^{F}	54.6				-.052	50.0		-.052
DU^{F}	385.6				-.182	400.3		-.182
ED^{F}	56.2			-.062	-.234	67.4		-.296



*Indicates price elasticity of supply equals zero for one year.

Figure 7. 1976 Long Run Equilibrium

Long Run Equilibrium for the 1985 World Wheat Market

The primary value of the 1976 long run equilibrium is that it will serve as a basis for comparison for the 1985 projected long run equilibrium. In this section, long run equilibrium conditions for the international wheat market for 1985 will be developed using the assumptions and techniques of this and the previous chapter. The results of this section will be comparable with the baseline projections of Chapter IV.

The 1985 equations for the simultaneous model are derived using the 1985 values of the exogenous variables in Appendix C. In general, a 1972-1976 five year average was assumed for variables which showed no clear trend. Though carry-in (both foreign and U. S.) is a constant, it is adjusted upward using the product of its ratio to production in 1976 and the projected 1985 production level. The determination of the initial values of the rest of the variables used in the 1985 model is unambiguous except for total foreign wheat demand (DMD^F). The location of this curve was established by adding the baseline projection of foreign demand for American wheat given a constant U. S. market share of 54 percent (from Table XXI, Chapter IV) to the projected foreign supply at the 1972-1976 average world wheat price of $163 per metric ton.

Because the foreign demand curve is determined from the baseline estimates of Chapter IV in which the change in stocks was assumed to be zero, it is presumed to be in its long run equilibrium position. Likewise the foreign and U. S. supply functions are assumed to be in long run equilibrium but, as in the 1976 equilibrium, carry-out is not

equal to carry-in at the still undetermined long run equilibrium price. These variables will be determined through an iterative process which will adjust the intercepts of the carry-out functions so that they will equal their respective carry-in levels at some initial price (in this case, the average world or U. S. price for 1972-1976). The U. S. demand equation will be adjusted for the change in U. S. carry-out and the whole system will be solved for an equilibrium price.[1] If, at the new equilibrium price, beginning and ending stocks are still not equal, the carry-out intercepts are adjusted again along with the U. S. demand function and the system is solved for a new equilibrium price. The process continues until the change in stocks is close to zero.

Beginning with a set of initial prices of $163/mt. at the world level and $3.24/bu. for the U. S., it took three iterations to solve for the 1985 long run equilibrium. The final set of equations is given in Table XXV. The final equilibrium prices--$126.15/mt. for the world and $2.56/bu. for the U. S.--are remarkably close to the 1976 long run prices. These prices are in terms of 1976 dollars. Hence, with continued inflation, they could be expected to be much higher in 1985. The quantities, however, are much higher. Equilibrium excess demand for American wheat in 1985 is projected to approach 40 million tons--an increase of about 33 percent over the 1976 long run equilibrium level.

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[1] In the determination of the 1976 long run equilibrium, both U. S. and foreign demand would shift if the carry-out function shifted but for 1985, the foreign long run demand schedule has already been fixed. Hence when foreign carry-out shifts, the other component of foreign demand--foreign domestic utilization (DU^F)--must shift by an equal amount in the opposite direction.

TABLE XXV

1985 PROJECTED AND LONG RUN EQUILIBRIUM EQUATIONS

Dependent Variables	Projected 1985 Equations					1985 Equations Adjusted for Long Run Equilibrium		
	Intercept	PW^{US}_{t-1}	PW^{US}_{t}	PW^{F}_{t-1}	PW^{F}_{t}	Intercept	PW^{US}	PW^{F}
SUP^{US}	81.0	2.7				81.0	2.7	
CI^{US}	23.6					23.6		
PD^{US}	57.5	2.7				57.5	2.7	
DMD^{US}	65.5		-6.0			63.7	-6.0	
FO^{US}	17.8					17.8		
SE^{US}	2.8					2.8		
FE^{US}	12.6		-3.3			12.6	-3.3	
CO^{US}	32.3		-2.7			30.4	-2.7	
ES^{US}	15.6	2.7	6.0			17.4	8.7	
SUP^{F}	428.6			.062		428.6		.062
CI^{F}	48.1					48.1		
PD^{F}	380.5			.062		380.5		.062
DMD^{F}	505.6				-.234	505.6		-.234
CO^{F}	56.6				-.052	54.7		-.052
DU^{F}	449.0				-.182	450.9		-.182
ED^{F}	77.0			-.062	-.234	77.0		-.296

These results can be compared with the baseline projections in Table XXI. Of particular interest is the difference between the baseline projections of the U. S. exports and the excess demand calculation of exports in the present model. The latter is ten million tons greater than the former. The reason that the difference is as large as it is can be traced to the prices used in the two models. The baseline projections assume that wheat and other prices remain at their average level for the 1972-1976 period, $163 per metric ton for the world and $3.24 per bushel for the U. S. These prices contrast sharply with the 1985 long run equilibrium prices of $126 per metric ton and $2.56 per bushel. Though the foreign sector of the 1985 simultaneous equation model was constructed to make excess demand equal to the constant market share baseline production of U. S. exports at 1972-1976 average prices, the projected high level of American excess supply at those prices resulted in a much lower set of long run equilibrium prices and, hence, a higher level of exports.

There is a strong possibility that should these long run equilibrium conditions exist or threaten to exist in 1985, the United States and other major exporting governments might find the $2.56 price for a bushel of wheat to be unacceptable. These governments might then impose supply controls or strengthen the controls they already have which would result in higher world prices.

An Increase in Long Run Equilibrium Supply

Up to this point, the long run functions have been assumed to be fixed. It should be remembered, however, that the original balance sheet projections in Chapter IV predicted that India, Brazil and the

People's Republic of China would become important exporters of wheat by 1985. The objective of this section is to determine the outcome should this or a similar set of events come to pass.

If the supply-demand balances for India, Brazil and China in Table XVII are added together, the total of 12.6 million tons can be used as a possible level of increase in long run world supply. This amount is added to the intercept term of the foreign long run supply function which in turn is used to form a new long run foreign excess demand function. Assume that this supply increase is purely a production increase and let carry-in remain constant. Thus, after American excess supply is equated with the new foreign excess demand, the system can be solved for a set of equilibrating prices. If these were long run equilibrium prices, carry-out would equal carry-in. In this case, the first set of prices resulted in an accumulation of stocks over the period. Therefore the carry-out intercepts were adjusted downward by an appropriate amount along with the aggregate demand schedule for the U. S. The foreign aggregate demand schedule was not adjusted because--as mentioned earlier--it is fixed based on balance sheet projections.

When the adjusted system is solved for the equilibrating prices, beginning and ending stocks are nearly equal and the results are considered an equilibrium solution. The set of equations which make up this solution are given in Table XXVI. As expected, the increase in world supply lowers prices which increases the quantity of wheat demanded in both the U. S. and the rest of the world. The excess demand for U. S. exports, however, decreases.

TABLE XXVI

A 1985 LONG RUN EQUILIBRIUM FOR THE WORLD WHEAT MARKET ASSUMING A 12.6 MILLION TON INCREASE ABOVE BASELINE PROJECTIONS

Dependent Variable	Intercept	PW^{US}	PW^{F}	Equilibrium Value[a]
SUP^{US}	81.0	2.7		86.4
CI^{US}	23.6			23.6
DMD^{US}	62.2	-6.0		50.4
CO^{US}	29.0	-2.7		23.8
SUP^{F}	441.2		.062	447.1
CI^{F}	48.1			48.1
DMD^{F}	505.6		-.234	483.1
CO^{F}	53.2		-.052	48.2
ES^{US}	18.8	8.7		35.9
ED^{F}	64.4		-.296	35.9

[a]These values are determined using the new equilibrium prices of \$1.96/bu. for PW^{US} and \$96.22/mt. for PW^{F}.

This is shown more clearly in Figure 8. The original 1985 long run excess demand and excess supply curves are designated as ED_1^F and ES_1^{US} respectively with an equilibrium price of 126.15 and a quantity exported of 39.7 million tons. An increase in world supplies of 12.6 million tons will shift the foreign excess demand function to the left causing a decrease in prices. At these lower prices, carry-out is greater than carry-in which means that United States' excess supply must adjust as carry-out is adjusted. A new long run equilibrium is achieved at a price of $96.22 per metric ton and a quantity exported of 35.9 million tons.

The balance sheet projections of the previous chapter merely showed that given the entrance of India, Brazil and China as exporters into the world wheat market, United States' wheat exports could decline to a level of only 14.6 million tons assuming constant prices. The current model allows prices to vary simultaneously with the changes in quantities and thereby demonstrates that the percentage variation in prices is likely to be much greater than the percentage variation in exports. It also brings to light the imperfectly competitive nature of the market. Because the aggregate supply and demand curves are very inelastic, the entrance into the market of a new major exporter or a permanent increase in supply by a major wheat importer or established exporter is likely to severely depress prices.

It was stated earlier that the geographic organization of a given shift in supply would have no effect on the model. Though this is true for the model itself, it is not necessarily true in the conduct of world trade--especially for this long run projected increase in world wheat supplies. Table XXVI shows the effect of an increase in the supplies of

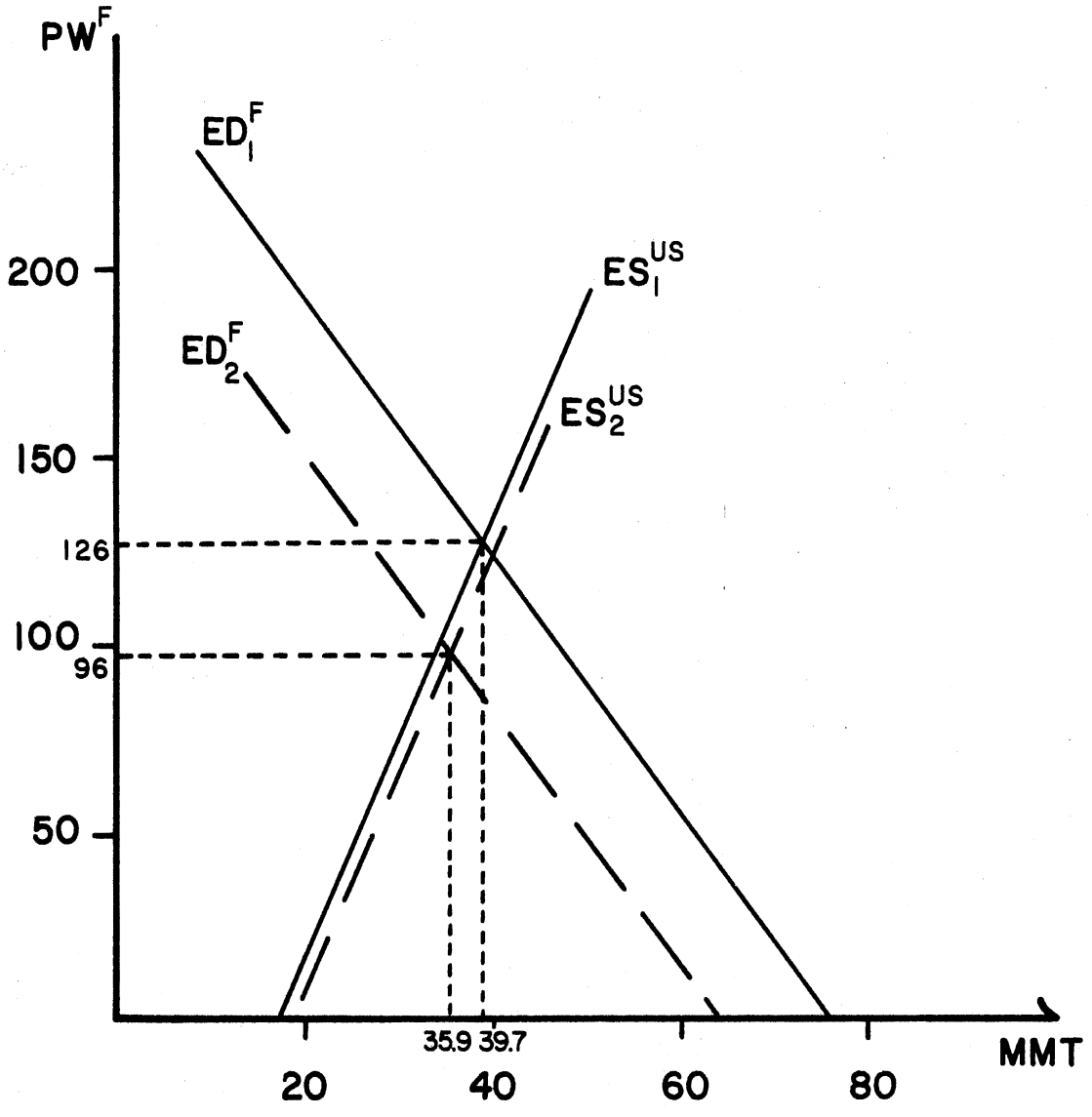

Figure 8. The Impact of a 12.6 Million Ton Increase in the Baseline Equilibrium on 1985 Prices and U. S. Exports

a major exporter such as Canada. Canadian wheat is of a high quality; the export infrastructure is already in place; and Canada has a comparative advantage in producing wheat. However, an increase by the same amount for a lesser exporter of wheat--particularly a new exporter such as India or China--would have a much smaller impact on the American share of the world market. It is conceivable that increases in supply behind tariff barriers within certain importing countries could also diminish American wheat exports and suppress prices but it is not likely to occur under the current policy framework in most of the major importing countries.

In addition, there does not appear to be any single country capable of increasing wheat production by an additional 12.6 million tons except the USSR. As pointed out in Chapter III, the weather conditions and the current farming practices in the Soviet Union make any large long term increase in wheat production beyond that already projected highly unlikely.

CHAPTER VI

IMPACTS OF WORLD SUPPLY INSTABILITY ON THE U. S. WHEAT ECONOMY IN 1985

The simultaneous equation model developed in Chapter V was used to determine prices and quantities for a hypothetical 1985 long run equilibrium. Though this set of results is instructive of future trends in world wheat demand and supply, it fails to consider the impact of short run variations in world supplies--an element which has caused wide gyrations in world wheat markets in the 1970's. This chapter will fill that void by using the model developed in Chapter V to look at the effect of short term changes in world supply on the United States and world markets in 1985. The analysis will emphasize the magnitude of the changes which result from a sharp increase or decrease in supply and the stability of the model as it returns to equilibrium.

The simultaneous equation model is a classic case of what is known in the literature as a cobweb model.[1] A cobweb model results when demand is a function of the current period's price and supply is a function of the previous period's price. A change in price will bring an instant response on the demand side but only a lagged response on the supply side. Depending on the relative slopes of the supply and demand curves, the return to equilibrium following a disturbance can

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[1]For a short discussion of a cobweb model, see Allen, 1970, pp. 1-6.

take one of three forms: a) the slope of the supply curve is greater than the absolute value of the slope of the demand curve, b) the slopes are equal, or c) the absolute value of the slope of the demand curve is greater than the slope of the supply curve. Any disturbance which results in disequilibrium will be followed by further movements away from equilibrium in (a) and by no movement either toward or away from equilibrium in (b). Only in (c) will the model be stable and return to equilibrium. An initial disturbance in (c) will be followed by alternating high and low prices with each successive price closer to equilibrium in a pattern known as damped oscillation. An examination of the price coefficients on supply and demand for both the U. S. and foreign sectors shown in Tables XXIV and XXV of Chapter V, reveals that the cobweb stability condition is met in both cases. The stability condition is also met at the world trade level, that is, the price coefficient of United States' excess supply is less than the absolute value of the price coefficient of foreign excess demand. The stability of the model will be confirmed as the impact of short run changes in world supply is analyzed.

Short Run Deviations from the Long Run Equilibrium

In this section, short run decreases and increases in world supplies will be traced through the model to show the response of prices and export quantities to these supply changes. The procedure will be similar to that followed in the analysis of Scenarios I and II in Chapter IV except that the effect of the initial shocks will be carried out over a two year period to show how the system responds over time.

A Short Run Decrease in World Supplies

Given the 1985 equilibrium shown in Table XXV, first assume (as in Scenario I of the Chapter IV) that there is a major crop shortfall totaling 33 million tons in a few of the world's important wheat producing countries. The impact of this crop shortfall upon U. S. wheat trade with the rest of the world is shown graphically in Figure 9. Initially, in frame 9-A, both long and short run equilibrium conditions exist in the world wheat market: 1) excess demand equals excess supply, 2) the world wheat price is equivalent to the U. S. wheat price plus transfer costs OT and 3) there is no incentive for producers or consumers to make production or consumption adjustments in subsequent years given their current supply and demand schedules. Frame 9-B shows a departure from long run equilibrium in the form of a short run decrease in supply in the foreign sector. This increases excess demand for wheat which dictates an increase in prices. Since foreign and United States' supplies are fixed in the short run (having been determined by the previous year's price), short run equilibrium can only be attained by decreases in the quantity of wheat demanded on both markets. In practice the demand adjustments will be made in the areas of feed use and carry-out stocks. Users of wheat for feed will substitute other cheaper grains and holders of stocks will sell wheat believing that future wheat prices are likely to decline.

Though a short run equilibrium is reached at price P_2 in Figure 9-B, long run equilibrium does not exist because there is an incentive for producers to make adjustments in supply. Therefore, in the following year, producers on both sides of the market will plan to increase their

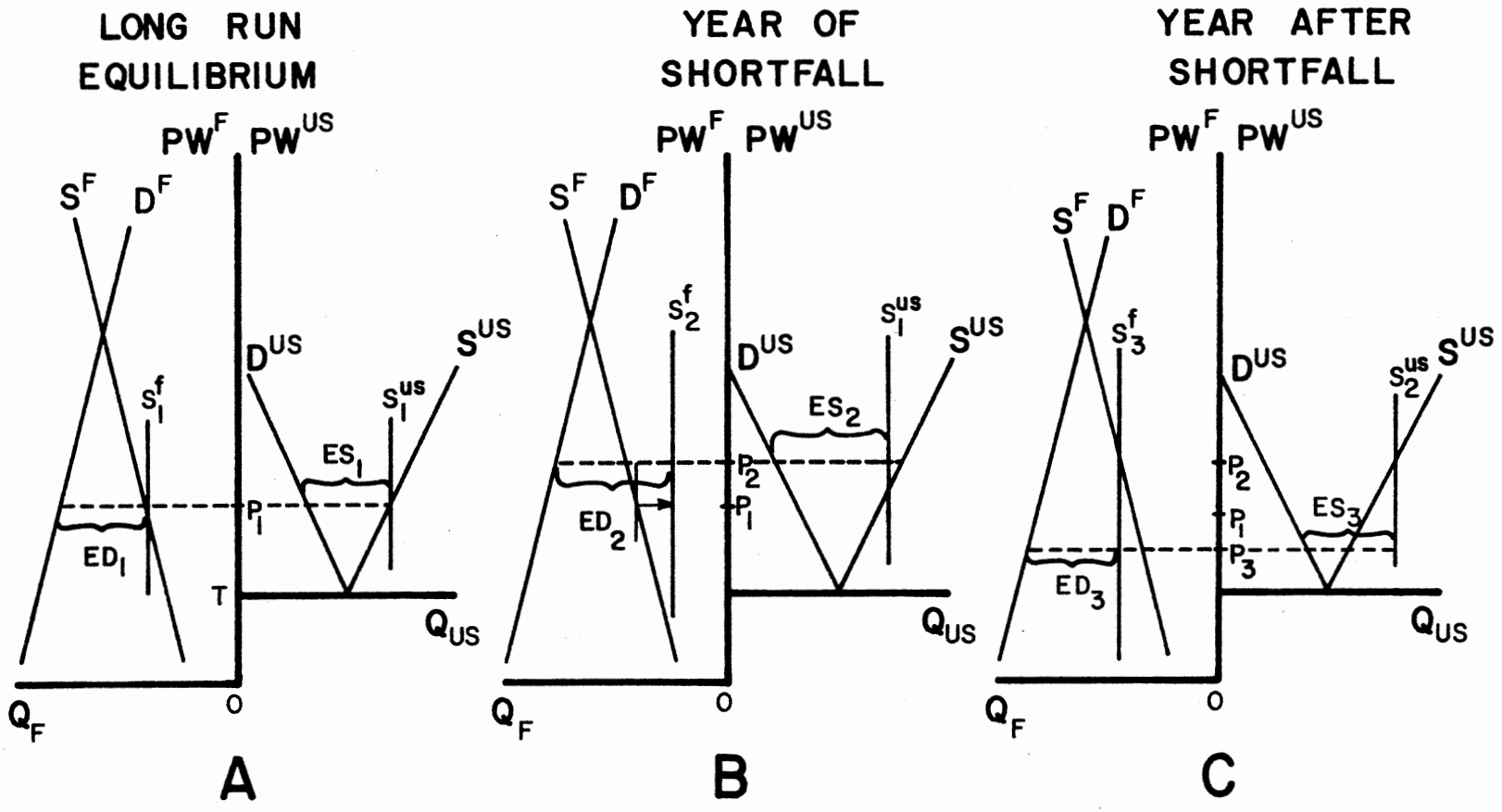

Figure 9. The Two Year Impact of a Single Year Shortfall in World Supply on Wheat Trade and Prices

quantity supplied to a level that is consistent with price P_2. Assuming that the world crop shortfall was only a one year departure from the long run supply function S^F, producers in the foreign sector in Figure 9-C will harvest an amount of wheat consistent with short run supply S_3^f--a substantial increase over the previous year. Likewise, American producers will increase their quantity supplied from S_1^{us} to S_2^{us}. The result is a short run increase in supply which causes the price to fall below the long run equilibrium level. Price P_3, however, is closer to the equilibrium price than was price P_2 indicating that there will be a gradual but oscillating return to long run equilibrium.

The process outlined in the graphical exposition can be traced more precisely using the set of equations from Table XXV. The U. S. and foreign aggregate supply and demand relationships can be substituted into:

$$SUP^{US} - DMD^{US} = DMD^{F} - [SUP^{F} - 33000]$$

in which the shortfall is added to excess demand on the right hand side. Assuming that the world wheat market is in long run equilibrium when this crop shortfall occurred, the supply functions will be determined by the long run equilibrium prices of \$2.56/bu (PW_{t-1}^{US}) for the U. S. and \$126.15/mt (PW_{t-1}^{F}) for the world. The relationship will therefore reduce to:

$$24339 + 6004\ PW_t^{US} = 102194 - 234.3\ PW_t^{F}$$

Substituting $PW_t^{US} = .0456 + .0199\ PW^{F}$ into the United States' excess supply function, the relationship can be solved for the world wheat price (PW_t^{F}).

Table XXVII shows the effect of a shortfall on world wheat market prices and quantities over a period of two years for 1985. The 1976 values are also given as a basis for comparison. The initial impact of the shortfall is to cause a sharp increase in prices (from $126 to $229 a metric ton on the world level) and to sharply reduce U. S. and world demand for wheat.[2]

In the United States, these changes are viewed as a shift in export demand. As shown in the table, only a portion of the total change in world supply is translated into a change in U. S. exports because the resulting change in prices will bring about changes in the quantity of wheat demanded for both the United States and the rest of the world. The 33 million ton world supply shortfall will increase American wheat exports by 8.9 million tons in the year of the shortfall. The additional U. S. exports are obtained from a decrease in feed use (3.3 mmt) and a decrease in normal carry-out stocks (5.5 mmt).[3] The other 24.1 million tons of the shortfall is made up by decreases in world consumption of wheat (18.6 mmt) and a decrease in world stocks (5.4 mmt). Presumably, the largest part of the decrease in stocks from the rest of the world would come from the other major world wheat exporters as they increase exports to meet the demand.

In keeping with the assumption of fixed supply in the short run, all the adjustments to the 33 million ton world supply shortfall in the first year are made on the demand side. In the second year, the production of

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[2]At prices above $3.55 per bushel in 1985 and $3.72 per bushel in 1976, American feed use of wheat (FE^{US}) is assumed to become price inelastic at a level of 800 thousand metric tons--the minimum amount of wheat used for feed over the 17 year study period.

[3]Due to round-off error, the sum of the elements may not equal the total in some cases.

TABLE XXVII

A SHORT RUN DECREASE IN WORLD SUPPLY OF 33 MILLION METRIC TONS

	Units	1985 Equili-brium	1985 First Year	1985 Second Year	1976 Equili-brium	1976 First Year	1976 Second Year
SUP^{US}	mmt	88.0	88.0	88.1	73.5	73.5	73.8
CI^{US}	mmt	23.6	23.6	18.1	21.0	21.0	15.8
PD^{US}	mmt	64.4	64.4	70.0	52.5	52.5	58.0
DMD^{US}	mmt	48.3	39.5	48.7	43.7	34.5	45.8
FO^{US}	mmt	17.8			15.3		
SE^{US}	mmt	2.8	20.8	20.8	2.6	17.9	17.9
FE^{US}	mmt	4.1	.8	4.3	4.6	.8	5.8
CO^{US}	mmt	23.6	18.1	23.7	21.1	15.8	22.1
$EX^{US}(=ED^{F})$	mmt	39.7	48.6	39.4	29.9	39.1	27.9
PW^{US}	$/bu.	2.56	4.60	2.50	2.57	4.59	2.20
SUP^{F}	mmt	436.4	403.4	442.7	390.7	357.7	391.8
CI^{F}	mmt	48.1	48.1	42.7	43.2	43.2	38.0
PD^{F}	mmt	388.3	355.3	400.0	347.5	341.6	353.8
DMD^{F}	mmt	476.0	452.0	476.7	420.6	396.8	424.9
CO^{F}	mmt	48.1	42.7	48.2	43.3	38.0	44.3
DU^{F}	mmt	427.9	409.3	428.5	377.3	358.8	380.6
PW^{F}	$/mt.	126.15	228.86	123.11	126.78	228.36	108.26

wheat in the United States and abroad increases in response to the previous year's high prices. U. S. production increases by 5.6 million tons while foreign producers recover from the previous year's disasterous crop and push their output to 11.7 million tons above equilibrium. Under normal circumstances, this big an increase in world production would cause prices to drop sharply below equilibrium but the rebuilding of depleted stocks absorbs most of additional output. As a result, the U. S. price is only seven cents below its' equilibrium level (though it is less than half of what it was only one year earlier).

Observe that the change in U. S. carry-out stocks is the same as the change in stocks for the rest of the world. This indicates the importance of the United States as the world's major wheat reserve and as the primary wheat exporter.

The variation in American exports follows closely the variation in prices. The abnormally high level of exports in the first year when the shortfall occurred are succeeded by exports below equilibrium in the second year as foreign countries are able to meet more of their needs for wheat from within or from more proximate sources. Though exports are lower, the lower prices make American wheat consumption as feed more attractive. The additional feed use and the accumulation of stocks partly make up for the fall in export demand but only at lower prices.

A Short Run Increase in World Supplies

The effects of extremely good crops in a few of the major world wheat producers can also be traced using the same technique and are shown in Table XXIII. Beginning with a state of long run equilibrium, assume--as in Chapter IV--that world wheat production is 25 million

TABLE XXVIII

A SHORT RUN INCREASE IN WORLD SUPPLY OF 25 MILLION METRIC TONS

	Units	1985 Equili-brium	1985 First Year	1985 Second Year	1976 Equili-brium	1976 First Year	1976 Second Year
SUP^{US}	mmt	88.0	87.9	87.9	73.5	73.5	73.5
CI^{US}	mmt	23.6	23.6	27.4	21.0	21.0	24.9
PD^{US}	mmt	64.4	64.4	60.5	52.5	52.5	48.7
DMD^{US}	mmt	48.3	56.7	48.1	43.7	52.1	42.3
FO^{US}	mmt	17.8	20.6	20.6	15.3	17.9	17.9
SE^{US}	mmt	2.8			2.6		
FE^{US}	mmt	4.1	8.8	4.0	4.6	9.3	3.8
CO^{US}	mmt	23.6	27.4	23.5	21.1	24.9	20.5
$EX^{US}(\equiv ED^{F})$	mmt	39.7	31.2	39.9	29.9	21.5	31.5
PW^{US}	$/bu.	2.56	1.15	2.59	2.57	1.15	2.59
SUP^{F}	mmt	436.4	461.4	435.7	390.7	415.7	390.2
CI^{F}	mmt	48.1	48.1	51.8	43.2	43.2	47.0
PD^{F}	mmt	388.3	413.3	383.9	347.5	372.5	343.2
DMD^{F}	mmt	476.0	492.6	475.6	420.6	437.1	420.2
CO^{F}	mmt	48.1	51.8	48.0	43.3	47.0	43.3
DU^{F}	$/mt.	427.9	427.9	427.6	377.3	390.1	376.9
PW^{F}	$/mt.	126.15	55.40	128.11	126.78	56.11	127.99

tons above normal. Foreign excess demand for American wheat will decline (a shift of the excess demand curve) forcing prices down. The lower prices will stimulate an increase in the quantity of wheat demanded (a movement along both the excess supply and excess demand curves) and, at some price below long run equilibrium, short run excess demand will be equated with short run excess supply.

For the United States, the world supply increase causes exports to fall by 8.5 million tons as the price of wheat drops to $1.15 per bushel. American feed use of wheat more than doubles as carry-out increases by 3.8 million tons. Consumption of wheat in the rest of the world increases with the lower prices and foreign wheat stocks rise to 3.7 million tons above equilibrium at the end of the year. Again, the change in American wheat stocks is comparable to the total change in stocks for the rest of the world.

There is one important difference between the shortfall and the increase in world supplies in the second year: the return to equilibrium is slower in the case of the world supply shortfall than for the case of the extra-large world wheat crop. This results because the feed use of wheat in the United States is restricted on the downside to a minimum of 800 thousand tons. Without this restriction, feed use would take on negative values at very high prices.

The Impact of Model Assumptions on Price Variability

The simultaneous equation model developed in Chapter V is a very useful analytical tool for determining the joint response of the international and American wheat markets to short term shifts in

important variables. Yet this model, like any other, is a mathematical abstraction of reality. For values in the neighborhood of the equilibrium prices and quantities, it may be a fairly accurate abstraction but as the deviations from equilibrium become greater and greater, forces which were not important in the estimation of the model may become very significant.

It is apparent from Tables XXVII and XXVIII that there is a high degree of variability present in the world wheat market. A decrease in supply of seven percent (33 mmt) in 1985 can cause prices to increase by nearly 80 percent while a five percent increase in supply (25 mmt) will result in a 55 percent decline in prices. It is therefore worthwhile to identify some of the forces which lay outside explicit specifications of the model but which are likely to have a significant impact on the actual level of wheat quantity and price variability. These forces will be divided into two sections--those which account for greater price variability than has shown up in the model and those which will result in a smaller range of price variations than specified in the model.

Forces Which Increase Price Variability

Primary among the forces which are likely to account for greater world price variability are attempts by governments to thwart the operation of the internal price system. The policies vary from price supports to increase producers' income in major producing countries to price ceilings to insure a cheap food supply in some developing countries. Many of these policies have been implicitly included in the model already since they have influenced the actual levels of supply and demand

from which the model was estimated. Yet a wide departure from normal market conditions, will catalyze a number of new policy responses.

For example, the major exporters--particularly the United States, Canada, and Australia--all have policies designed to prevent prices from falling below a set minimum level. Given a 25 million ton increase in world supplies, these policies would take effect. By supporting a minimum level of prices, these governments encourage a greater accumulation of stocks than would occur under the "normal" conditions shown in Table XXVIII. In addition, the minimum prices will also prevent producers from decreasing production by a sufficient amount in the first year which means that the return to equilibrium will take longer. Producers will also have to accept lower than equilibrium prices in the second year in order to allow the market to clear the additional supplies which have resulted from government price supports.

Likewise, for a sharp decrease in world supplies, the policy response of some countries might be to impose an embargo on wheat exports as the EEC did in 1973. This policy would further increase the price of wheat and shift a greater proportion of the burden of the shortfall onto the exporting countries without embargoes.

It would be possible to assume the activation of some of these policy responses for wide variations in world wheat prices as part of the model, but the exact nature of these policies cannot be known. Without going through the mechanics of imposing restrictions on the model and deriving the impact of a supply shift, it is possible to see that any effective attempt to inhibit the functioning of the price system by any one country will prolong the return to equilibrium and increase the level of variability for the other market participants.

A second set of factors which may result in greater price variability than that predicted by the model are the physical limitations of the world wheat marketing system. A major crop failure in one part of the world, for example, may heavily tax the shipping and terminal capacity of the countries involved. Transportation costs may increase sharply resulting in a very large price difference between exporting and importing regions. Producer prices in major exporting countries will not increase as rapidly as they do in the model which will delay the supply response and lengthen the time required to return to equilibrium.

In the same way, a large crop in a major producing country may result in extremely low wheat prices in that country for a longer period of time than implicitly assumed in the model because the surplus cannot be exported or consumed quickly. Inadequate storage facilities may limit the amount of carry-over stocks which--as specified in the statistical model--have been a key element in bringing a rapid return to equilibrium.

Finally, even if the marketing system did not have any capacity or transportation limitations, it is not likely that the economic agents in the system--consumers, wholesalers, producers, feed users, and others--could all respond to major price changes as rapidly as portrayed in the model. In other words, the demand and supply curves probably tend to become much more price inelastic in the short run for large price movements. This tendency alone will prolong the return to equilibrium and widen the variation in prices.

Forces Which Tend to Diminish Price Variability

There are at least two major reasons the model may understate the

true magnitude of price variability for large shifts in world supply. The first is the assumption that the prices of wheat substitutes in consumption and production remain constant. As with a number of other assumptions, this one is valid for wheat prices near equilibrium but as prices begin to deviate by large amounts, price changes will spread out to other grains and foodstuffs.

If, as shown in Table XXVII, the price of wheat were to rise sharply because of a major wheat crop failure, the full force of the shortfall would be cushioned by the substitution of rice, coarse grains, potatoes and other foods for wheat by the worlds' populations. Likewise, an extra large world wheat crop would result in the substitution of wheat for other grains, particularly in feed use, thus transmitting some of the impetus for a wheat price decline to those grains.

Of course wheat prices are also a function of the supplies of other grains. A major change in the supply of rice in Asia, for example, will have a direct impact on wheat exports and prices. Hence to a certain extent, wheat price variability is also increased as a result of wheat's substitutability. Yet unless there are concurrent disruptions in a number of grain markets, the frequency of wheat price fluctuations may increase but the magnitude of those fluctuations should be lessened by the interaction of the various grain markets.

A final abstraction which tends to overstate the variability of the model is the assumption of fixed short run supply. With different harvest times for different lattitudes, only a certain percentage of the world wheat supply is fixed at any given time of the year. For this reason, total world wheat supplies are never perfectly inelastic for a year's time.

If the forces which contribute to price variability were weighed against those which diminish it, the former would appear to be more dominant. Rigidities in the marketing system and the reluctance of policy-makers to accept the consequences of extremely low or extremely high prices would tend to cancel out the market forces which might help dissipate major price movements over other grains. Hence, the simultaneous equation model which has been used in this and the previous chapter to show how small changes in supplies will result very wide price movements, probably understates the full impact on prices.

Model Conclusions

The simultaneous equation model estimated and discussed in these last two chapters has provided an insight into the economic framework within which American wheat is exchanged on international markets. Though this model may have oversimplified a very intricate and complicated system of trade patterns and economic relationships, the basic conclusions should remain intact even with the use of more sophisticated models and techniques. These conclusions are: 1) small percentage changes in supply can have a very large impact on prices; 2) given a short term change in supply, the return to equilibrium, ceteris paribus, will occur very rapidly; and 3) more than any other single country, the supplies, exports and carry-over stocks of the United States are essential in providing a measure of stability in international wheat trade.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The central purpose of this study was to analyze the supply and demand relationships in the world wheat market and to develop models to assist in forecasting the future price of American wheat. This was accomplished by first dividing the world into major importing and exporting countries and regions. For the 12 countries chosen for individual analysis, data were collected and balance sheet estimates were made of their production, feed use, food use, and seed use of wheat. The Soviet Union and the People's Republic of China merited a balance sheet analysis, but the data were not available. Instead, only aggregate production and domestic utilization functions were estimated for these two countries. The other countries of the world were combined into six regional groupings for which production and utilization relationships were also estimated.

Next, projected 1985 values for the independent variables in each of the country and region equations were used to obtain 1985 projections for all of the supply and demand relationships. In general, variables such as income or population were trended out to 1985. For variables such as prices, a 1972-1976 five year average was usually used.

The balance sheet projections for the 12 individual countries were then aggregated into production and domestic utilization and the difference between these two relationships (for both countries and regions) was used as an estimate of a particular country's or region's net import demand. The sum of these net import demands, excluding the United States, provided an estimate of the excess demand for American wheat exports.

Two alternative excess demands were considered. The first assumed that current trends in Brazil, India and China would continue and that each would be important wheat exporters in 1985. The second more plausible alternative--denoted as the "baseline" projection--assumed that these three countries would become self-sufficient in wheat by 1985 but would not become wheat exporters. Possible short run deviations from the baseline, based on study period data, were examined in Scenarios I and II as a way of illustrating the relative extremes in export demand for U. S. wheat. Wide variations were shown to be possible but the influence on prices was not explicitly determined.

To remedy this lack of price and quantity interaction, a simultaneous equation model was developed in which the wheat economy of the United States was linked to the wheat economy of the rest of the world. The components of the U. S. sector of the model were projected out to 1985 while the baseline projections developed previously were used in the rest of the world or foreign sector. After the model was collapsed into simple price-quantity relationships (by fixing the values of nonprice independent variables) and after adjustments were made in the carry-out functions, a 1985 long run equilibrium was determined. An alternative

long run equilibrium was developed to take account of the possible emergence of Brazil, India and China as exporters of wheat.

The baseline 1985 long run equilibrium pointed to an increase in American wheat exports but at a price of about $2.56 per bushel in 1976 dollars. If world supplies increase by 12.6 million tons as a result of Brazil, India and China entering the wheat export market, American wheat exports would be ten percent less than the baseline projections while prices would drop to $1.96 per bushel.

The interaction of prices and quantities in the United States and the rest of the world was even more apparent in the analysis the impact of short run shifts in world wheat production. A comparative statics approach was used to demonstrate the effect of a 33 million metric ton decrease and a 25 million ton increase in world supplies. These changes in supplies corresponded to the maximum deviations to occur on either side of the aggregated predicted levels of world production during the 1960-1976 study period and they are the same deviations posited in Scenarios I and II.

The model showed that a shortfall in world production would cause U. S. prices in 1976 dollars to rise to $4.60 a bushel and that a world bumper crop would depress prices to $1.15 a bushel in 1976 dollars. In both cases the return to equilibrium was rapid with prices only slightly below or above the long run equilibrium level in the year following the initial change.

Conclusions

In the major findings of this study, a number of significant trends and relationships have been revealed and quantified. Through the use of

the geographic and balance sheet breakdowns it was determined that Europe was a shrinking market for U. S. wheat exports. The Common Agricultural Policy of the EEC has closed Community wheat markets to competition from abroad (except for some qualities of wheat not produced in the EEC) and stimulated production to the extent that the area is projected to have a surplus of six million tons by 1985.

The developing countries and regions, on the other hand, were projected to be expanding markets for wheat exports. Egypt, the Rest of Africa, the Rest of Asia, and the Rest of Latin America had especially fast growing markets spurred by increasing incomes, population and urbanization.

There were three notable exceptions among the developing countries: Brazil, India and the People's Republic of China. In each of these countries, production on the basis of current and past trends was projected to outstrip demand by 1985. For Brazil and India, these production increases are the result of government agricultural policies and the introduction of new high-yielding wheat varieties suitable to the region. For the People's Republic of China, little is known about the factors which affect Chinese wheat consumption and production.

The three major exporting countries excluding the United States--Argentina, Australia and Canada--were projected to have very little change in their exportable surplus between 1976 and 1985. The governments of Australia and Canada, especially, have policies designed to restrict production in the event of a build up of wheat inventories. Given the projected long run equilibrium price of $2.56 per bushel, it is not likely that these countries will have the incentive to sharply expand their wheat output.

One of the most significant and perhaps the most expected result of this study was the pivotal role of the Soviet Union in the international wheat market. As the world's largest producer of wheat, the effects of Russian agricultural policies and variable yields can have a very large impact on world demand and supply.

The simultaneous equation model which was developed to measure the interaction between the United States wheat economy and the international market quantified many relationships which were understood but not clearly defined. The projection and construction of the 1985 long run equilibrium shows an increase in United States' wheat exports with almost no change in prices.

The model's most important findings, however, were in the area of the impact of short run changes in supply on the world and U. S. wheat markets. Wide variations in prices resulted from relatively small shifts in world supply. If the model is an accurate representation of the dynamics of the world wheat market, these price variations should be short-lived. In the year following the initial shock, prices were shown to have almost returned to equilibrium, given no restrictions on the estimated market relationships.

This model illustrated the central role of the United States in providing stability to world wheat markets. The variations in carry-out stocks were the key to a quick return to equilibrium since the change in American stocks equalled the change in stocks for the rest of the world combined. To provide this stability to world wheat markets, the model assumes that the United States is willing to accept wide variations in prices, stocks, feed use, and exports. For a certain range of price variations, this may be a valid assumption, but for the extreme deviations

depicted in Chapter VI, American policy makers are likely to take action to mitigate the effects on producers and/or consumers.

Limitations and Need for Further Study

This study suffers from a number of limitations and shortcomings, some of which could not be avoided. Primary among these was the failure to adequately explain and predict the future trends in wheat production and utilization in the USSR and the People's Republic of China. This shortcoming is not unique to this study but since 1972 (and earlier) has been the concern of researchers and policy makers alike. Any method or information which will improve the forecasts of the wheat export demands of these two Communist countries would be of great value in improving the forecast of world wheat prices.

A second major shortcoming of the study is that the simultaneous equation model does not anticipate major policy changes in important importing or exporting countries in response to wide price variations. As a result, world wheat markets are portrayed as being much more stable and price responsive that they really are. Without much difficulty, a few hypothesized policy responses could be easily incorporated into the model and the impact on prices and trade could be determined, but it would be difficult to incorporate all the restrictions likely to occur.

The model, as mentioned in the previous chapter, also ignores the substitutability of wheat for other food and feed grains. It would have been desirable to link the wheat, rice, and feed grain economies of all the countries and regions of the world into one large grain model had time and resources permitted.

In addition, the study of the influence of different crop harvest times on the marketing of wheat is still a valid endeavor if and when quarterly data should become available. This type of study could reveal very important insights into the comparative advantage of southern hemisphere wheat exporters relative to northern hemisphere exporters.

Finally and, perhaps, most significant, this study does not estimate or predict trade flows. An increase in world export demand may or may not be advantageous to the United States. The ability of U. S. wheat to compete with the wheat of the other major exporters has not been analyzed explicitly. Implicitly, it is included in the simultaneous equation model as an increase in demand for American exports resulting from aggregate world supply shift but quality differences, geographic location and harvest year can play an important role in determining which exporting country will benefit from an increase in demand in a given importing country. An analysis of future wheat trade flow patterns would help clarify the structure of the world wheat market and define the competitive relationship of the major exporters.

At the beginning of this study the question was asked whether the price movements on the world wheat market since 1972 reflected a fundamental change in institutions or economic relationships or whether the price fluctuations were merely the result of short term aberrations in the market. This question has not been addressed directly but it appears--given the projections and the analysis of the variations in the world market--that the evidence weighs more heavily on the side of short term aberrations. The models developed have shown that trends are currently present which will bring about a long term equilibrium price which will be well below the high prices of 1973 and 1974. They

have also shown that short term aberrations in world supplies can cause the disruptions similar to those experienced on world grain markets in the first half of the seventies. By allowing for a few rigidities in the pricing and marketing system, it is not surprising that a one year supply shortfall could sustain higher wheat prices over two or three years.

Much has been learned about the atmosphere in which world wheat commerce is conducted. It is hoped that the analysis developed in this study will provide a foundation for future study of the United States' role in the world wheat economy.

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APPENDIXES

APPENDIX A

DEFINITION OF VARIABLES USED IN THE ESTIMATION OF THE BALANCE SHEET EQUATIONS OF CHAPTER III

DEFINITION OF BALANCE SHEET VARIABLES

Country	Country Suffix	Dependent Variable Prefixes, Definitions and Units						
		HH- Wheat Hectares Harvested 1000 ha	YLD- Wheat Yields mt/ha	PDN- Wheat Production 1000 mt	FOOD- Food Use of Wheat 1000 mt	FEED- Feed Use of Wheat 1000 mt	SEED- Seed Use of Wheat 1000 mt	DU- Domestic Utilization of Wheat 1000 mt
Germany	-G	HHG	YLDG	PDNG	FOODG	FEEDG	SEEDG	--
Italy	-I	HHI	YLDI	PDNI	FOODI	FEEDI	SEEDI	--
Netherlands	-N	HHN	YLDN	PDNN	FOODN	FEEDN	SEEDN	--
France	-F	HHF	YLDF	PDNF	FOODF	FEEDF	SEEDF	--
United Kingdom	-UK	HHUK	YLDUK	PDNUK	FOODUK	FEEDUK	SEEDUK	--
Rest of Western Europe	-RWEU	--	--	PDNRWEU	--	--	--	DURWEU
Egypt	-E	HHE	YLDE	PDNE	FOODE	FEEDE	SEEDE	--
Rest of Africa	-RAF	--	--	PDNRAF	--	--	--	DURAF
India	-IN	HHIN	YLDIN	PDNIN	FOODIN	FEEDIN	SEEDIN	--
Japan	-J	HHJ	YLDJ	PDNJ	FOODJ	FEEDJ	SEEDJ	--
Rest of Asia	-RAS	--	--	PDNRAS	--	--	--	DURAS
Brazil	-B	HHB	YLDB	PDNB	FOODB	FEEDB	SEEDB	--
Argentina	-AR	HHAR	YLDAR	PDNAR	FOODAR	FEEDAR	SEEDAR	--
Rest of Latin America	-RSA	--	--	PDNRSA	--	--	--	DURSA
Canada	-C	HHC	YLDC	PDNC	FOODC	FEEDC	SEEDC	--
Australia	-AU	HHAU	YLDAU	PDNAU	FOODAU	FEEDAU	SEEDAU	--
Rest of Oceania	-ROC	--	--	PDNROC	--	--	--	DUROC
USSR	-CCP	--	--	PDNCCP	--	--	--	DUCCP
People's Republic of China	-PRC	--	--	PDNPRC	--	--	--	DUPRC
Eastern Europe	-EEU	--	--	PDNEEU	--	--	--	DUEEU

DEFINITION OF INDEPENDENT VARIABLES

Independent Variable	Definition
YR	Trend--Last two digits of the year.
D6776	Dummy variable[a] = 1 from 1967-1976 (Period of the Common Agricultural Policy) = 0 otherwise
DYR6776	Dummy slope[a] = YR from 1967-1976 (Period of the CAP) = 0 otherwise
DPPLCG	Deflated producer price of wheat in Germany, marcs/mt
D7476	Dummy variable = 1 from 1974-1976 (Period following discontinuation of the EEC denaturing premium) = 0 otherwise
DYR7476	Dummy slope = YR from 1974-1976 (Period following discontinuation of the EEC denaturing premium) = 0 otherwise
RWCRNPI	Ratio of producer price of wheat to producer price of corn, Italy
POPI	Population of Italy, millions
D6773	Dummy variable = 1 from 1967-1973 (Period of EEC denaturing premium) = 0 otherwise
DYR6773	Dummy slope = YR from 1967-1973 (Period of EEC denaturing premium) = 0 otherwise
D7176	Dummy variable = 1 from 1971-1976 (Period of UK adoption of CAP) = 0 otherwise
DYR7176	Dummy slope = YR from 1971-1976 (Period of UK adoption of the CAP) = 0 otherwise
D73	Dummy variable = 1 for 1973 (Year of EEC embargo on wheat exports) = 0 otherwise
LDPPLCE	Lagged deflated producer price of wheat, Egypt, piasters/mt
D6976	Dummy variable = 1 for 1969-1976 (Period of a new wheat pricing policy) = 0 otherwise
DYR6976	Dummy slope = YR for 1969-1976 (Period of a new wheat pricing policy) = 0 otherwise
D6876	Dummy variable = 1 from 1968-1976 (Period of green revolution and a new Indian agricultural policy) = 0 otherwise
DYR6876	Dummy slope = YR from 1968-1976 (Period of green revolution and a new Indian agricultural policy) = 0 otherwise

Independent Variable	Definition
DWPLCIN2	Deflated wholesale price of wheat, India, rupees/mt, January/December crop year
LDWPLCIN2	Same as DWPLCIN2 but lagged one year.
DPPRCJ	Deflated producer price of rice, Japan, 1000 yen/mt
LDXRAWPJ	Deflated average wheat import price, lagged one year and adjusted for changes in the U. S. exchange rate, Japan, yen/mt
D6776	Dummy variable[b] = 1 from 1967-1976 (Period of new Brazilian agricultural policy) = 0 otherwise
DYR6776	Dummy slope[b] = YR from 1967-1976 (Period of new Brazilian agricultural policy) = 0 otherwise
DPPLCB	Deflated producer price of wheat, Brazil, cruz/60 kg
LDPPLCB	Same as DPPLCB but lagged one year
PCYB	Real per capita income, Brazil, cruz/person
D636476	Dummy variable = 1 in 1963, 1964 and 1976 (Good weather years, Argentina) = 0 otherwise
POPAR	Population, Argentina, millions
RLWCPAR	Ratio of wheat price lagged one year to corn price, Argentina
DPPLCC	Deflated producer price of wheat, Canada, Canadian $/mt
D70	Dummy variable[c] = 1 in 1970 (Year of Operation LIFT) = 0 otherwise
LHHC	Hectares harvested lagged one year, Canada, 1000 ha
PCYC	Real per capita income, Canada, 1975 Canadian $ per person
LSEEDC	Seed use of wheat lagged one year, Canada, 1000 mt
D69	Dummy variable = 1 in 1969 (Year prior to Operation LIFT) = 0 otherwise
LHHAU	Hectares harvested lagged one year, Australia, 1000 ha
D70	Dummy variable[d] = 1 in 1970 (Year of effective Australian production quotas on wheat) = 0 otherwise
DPPUAU	Deflated producer price of faq wheat, Australia, US $/mt
PCYAU	Real per capita income, Australia, Australian $/person
RWBARPAU	Ratio of producer wheat price to barley export price, Australia
D656772	Dummy variable = 1 in 1965, 1967 and 1972 (Bad weather years, Australia) = 0 otherwise

[a]Definition applies only to Western European country and regional equations.

[b]Definition applies only to Brazil.

[c]Definition applies only to Canada.

[d]Definition applies only to Australia.

APPENDIX B

BALANCE SHEETS FOR COUNTRIES AND REGIONS OF THE WORLD

BALANCE SHEET: WEST GERMANY 22:25 FRIDAY, DECEMBER 7, 1979 1

OBS	CIG	PDNG	SUPG	FOODG	FEEDG	SEEDG	DMDG	BALG	IMPG	EXPG	COG	YR1	ERG
1	2322	4964	7286	3940	1603	237	5780	1506	2204	825	2737	60	148
2	2737	4039	6776	3876	1834	272	5982	794	3515	1179	3019	61	111
3	3019	4591	7610	3820	1619	241	5680	1930	1870	629	3021	62	150
4	3021	4855	7876	3771	1755	245	5771	2105	1889	1156	2723	63	115
5	2723	5046	7769	3794	1663	242	5699	2070	1484	656	2770	64	128
6	2770	4349	7119	3833	1603	235	5671	1448	1623	659	2316	65	96
7	2316	4534	6850	3723	1704	240	5667	1183	1551	627	2185	66	-78
8	2185	5819	8004	3707	2191	248	6146	1858	1835	566	2488	67	639
9	2488	6197	8685	3680	2632	254	6566	2119	2543	765	3578	68	319
10	3578	6001	9579	3560	3418	258	7236	2343	1802	2216	1616	69	313
11	1616	5661	7277	3489	3059	258	6806	471	2539	913	1809	70	288
12	1809	7141	8950	3572	3024	286	6882	2068	2737	898	2658	71	1249
13	2658	6608	9266	3769	3715	266	7750	1516	2767	1186	2312	72	785
14	2312	7134	9446	3694	3129	288	7111	2335	2258	1182	2433	73	978
15	2433	7724	10157	3753	2259	283	6295	3862	1446	1156	2992	74	1160
16	2992	7014	10006	3743	3053	308	7104	2902	1676	1521	2789	75	268
17	2789	6701	9490	3764	3150	294	7208	2282	1418	1386	.	76	.

BALANCE SHEET: ITALY 22:25 FRIDAY, DECEMBER 7, 1979 2

OBS	YR	CII	PDNI	SUPI	FOODI	FEEDI	SEEDI	DMDI	BALI	IMPI	EXPI	COI	YR1	ERI
1	60	860	6804	7664	7550	120	777	8447	-1183	2370	67	1000	60	120
2	61	1000	8301	9301	8175	70	738	8983	318	902	129	1060	61	31
3	62	1060	9498	10558	8232	75	779	9086	1472	276	191	1535	62	22
4	63	1535	8127	9662	8406	65	751	9222	440	485	213	751	63	-39
5	64	751	8586	9337	8475	74	755	9304	33	712	270	400	64	75
6	65	400	9776	10176	8648	96	736	9480	696	1046	409	1200	65	133
7	66	1200	9400	10600	8668	90	746	9504	1096	1031	771	1160	66	196
8	67	1160	9596	10756	8300	100	700	9100	1656	941	219	1096	67	1282
9	68	1096	9655	10751	9134	264	720	10118	633	1574	400	1631	68	176
10	69	1631	9585	11216	8870	270	736	9876	1340	1290	586	1318	69	726
11	70	1318	9689	11007	8454	149	720	9323	1684	1440	763	1074	70	1287
12	71	1074	9994	11068	9612	355	684	10651	417	1379	594	1104	71	98
13	72	1104	9421	10525	9334	200	645	10179	346	1211	693	375	72	489
14	73	375	8920	9295	9713	400	645	10758	-1463	3088	316	1281	73	28
15	74	1281	9690	10971	9180	350	620	10150	821	1636	459	1211	74	787
16	75	1211	9480	10691	9300	300	710	10310	381	1910	636	1444	75	211
17	76	1444	9133	10577	8800	100	684	9584	993	2428	830	.	76	.

BALANCE SHEET: NETHERLANDS 22:25 FRIDAY, DECEMBER 7, 1979 3

OBS	YR	CIN	PDNN	SUPN	FOODN	FEEDN	SEEDN	DMDN	BALN	IMPN	EXPN	CON	YR	ERN
1	60	141	591	732	1072	358	19	1449	-717	940	12	143	60	68
2	61	143	482	625	1099	479	20	1598	-973	1360	12	272	61	103
3	62	272	604	876	1027	170	19	1216	-340	544	21	123	62	60
4	63	123	536	659	1043	128	23	1194	-535	795	51	172	63	37
5	64	172	738	910	1007	96	24	1127	-217	710	304	165	64	24
6	65	165	691	856	1000	47	25	1072	-216	740	186	251	65	87
7	66	251	596	847	998	81	26	1105	-258	611	141	180	66	32
8	67	180	740	920	954	46	26	1026	-106	942	371	88	67	377
9	68	88	673	761	967	282	29	1278	-517	1279	567	169	68	26
10	69	169	697	866	1050	623	24	1697	-831	1618	741	101	69	-55
11	70	101	645	746	924	305	24	1253	-507	1310	637	83	70	83
12	71	83	705	788	935	332	24	1291	-503	1482	670	194	71	115
13	72	194	672	866	930	920	24	1874	-1008	2049	771	186	72	84
14	73	186	725	911	961	437	22	1420	-509	1526	508	324	73	185
15	74	324	746	1070	973	297	18	1288	-218	1684	1039	463	74	-36
16	75	463	528	991	954	86	22	1062	-71	2152	1842	261	75	-22
17	76	261	710	971	990	120	30	1140	-169	1401	1012	.	76	.

BALANCE SHEET: UNITED KINGDOM 22:25 FRIDAY, DECEMBER 7, 1979 4

OBS	YR	CIUK	PDNUK	SUPUK	FOODUK	FEEDUK	SEEDUK	DMDUK	BALUK	IMPUK	EXPUK	COUK	YR1	ERUK
1	60	1106	3040	4146	5345	1681	152	7178	-3032	4711	8	1177	60	494
2	61	1177	2615	3792	5036	1482	178	6696	-2904	4692	9	1206	61	573
3	62	1206	3973	5179	5167	2294	152	7613	-2434	4258	143	1204	62	477
4	63	1204	3263	4467	5121	1811	173	7105	-2638	4605	19	1235	63	713
5	64	1235	3688	4923	5089	2417	197	7703	-2780	4190	14	1125	64	271
6	65	1125	4172	5297	5282	2932	176	8390	-3093	4664	13	1287	65	271
7	66	1287	3475	4762	5122	2242	184	7548	-2786	4176	16	1205	66	169
8	67	1205	3900	5105	5194	2369	190	7753	-2648	4077	16	1286	67	127
9	68	1286	3470	4756	5380	2563	163	8106	-3350	4576	12	1258	68	-44
10	69	1258	3364	4622	5332	2732	196	8260	-3638	4781	21	1129	69	-7
11	70	1129	4235	5364	5045	4083	212	9340	-3976	5359	21	1174	70	188
12	71	1174	4814	5988	5061	3156	219	8436	-2448	3829	13	1004	71	364
13	72	1004	4779	5783	5043	3708	222	8973	-3190	4535	25	1162	72	158
14	73	1162	5008	6170	5062	2601	240	7903	-1733	3114	51	1139	73	191
15	74	1139	6022	7161	5104	3706	200	9010	-1849	2935	63	1475	74	-452
16	75	1475	4488	5963	5111	2889	241	8241	-2278	4264	305	1368	75	313
17	76	1368	4740	6108	5394	2915	255	8564	-2456	3422	271	.	76	.

BALANCE SHEET: FRANCE 22:25 FRIDAY, DECEMBER 7, 1979 6

OBS	YR	CIF	PDNF	SUPF	FOODF	FEEDF	SEEDF	OMDF	EALF	IMPF	EXPF	COF	YR1	ERF
1	60	1508	11014	12522	5998	2715	713	9426	3096	401	1559	1906	60	32
2	61	1906	9492	11398	5518	2046	814	8778	2620	360	1833	1687	61	-540
3	62	1687	14053	15740	5952	3183	869	10024	5716	596	2978	3248	62	86
4	63	3248	10249	13497	5767	2703	794	9264	4233	769	2681	2252	63	69
5	64	2252	13838	16090	5596	3660	815	10071	6019	709	4607	2000	64	121
6	65	2000	14349	16349	5673	3587	716	9976	6373	748	4782	2660	65	-321
7	66	2660	11297	13957	5454	3608	716	9778	4179	687	3018	1706	66	142
8	67	1706	14288	15994	5284	3545	746	9575	6419	460	4320	1230	67	1329
9	68	1230	14985	16215	5168	3389	729	9286	6929	600	6048	1286	68	195
10	69	1286	14459	15745	5150	4010	675	9835	5910	475	6125	834	69	-574
11	70	834	12922	13756	4897	4163	726	9786	3970	358	3308	992	70	28
12	71	992	15482	16474	4865	3792	712	9369	7105	191	5585	1447	71	264
13	72	1447	18046	19493	4843	4390	711	9944	9549	332	8039	1487	72	355
14	73	1487	17792	19279	4791	3791	742	9324	9955	246	8859	1389	73	-47
15	74	1389	19141	20530	4851	3771	612	9234	11296	371	8119	2827	74	721
16	75	2827	15041	17868	4898	2552	640	8090	9778	414	9178	1974	75	-960
17	76	1974	16150	18124	4960	3660	688	9308	8816	184	6811	.	76	.

BALANCE SHEET: THE REMAINDER OF WESTERN EUROPE 22:25 FRIDAY, DECEMBER 7, 1979 7

OBS	YR	CIRWEU	PDNRWEU	SUPRWEU	DURWEU	BALRWEU	IMPRWEU	EXPRWEU	CORWEU	YR1	ERRWEU
1	60	4428	13287	17715	16927	788	3454	509	3565	60	168
2	61	3565	12871	16436	16808	-372	4493	554	3177	61	390
3	62	3177	14981	18158	17624	534	3850	523	3815	62	46
4	63	3815	14770	18585	17522	1063	3053	596	3326	63	194
5	64	3326	14104	17430	16879	551	3635	662	3842	64	-318
6	65	3842	15363	19205	17032	2173	3961	713	4963	65	458
7	66	4963	15298	20261	17011	3250	2913	947	4531	66	685
8	67	4531	17557	22088	17446	4642	2310	1837	4919	67	196
9	68	4919	16920	21839	17809	4030	2220	1569	4452	68	229
10	69	4452	15794	20246	17815	2431	2819	1348	4081	69	-179
11	70	4081	14348	18429	18298	131	3164	758	2890	70	-353
12	71	2890	18464	21354	18881	2473	2711	1157	3999	71	28
13	72	3999	16674	20673	18568	2105	3192	1886	3740	72	-329
14	73	3740	15821	19561	17584	1977	3688	1217	4513	73	-65
15	74	4513	19577	24090	19239	4851	3089	2196	5733	74	11
16	75	5733	16249	21982	19424	2558	2904	2469	4136	75	-1133
17	76	4136	19266	23402	19169	4233	2447	2198	.	76	.

BALANCE SHEET: EGYPT 22:25 FRIDAY, DECEMBER 7, 1979 10

OBS	YR	CIE	PDNE	SUPE	FOODE	SEEDE	DMDE	BALE	EXPE	IMPE	COE	YR1	ERE
1	60	412	1500	1912	2379	111	2490	-578	8	994	519	60	-111
2	61	519	1437	1956	3034	105	3139	-1183	4	1709	547	61	-25
3	62	547	1606	2153	3197	111	3308	-1155	15	1721	563	62	-12
4	63	563	1494	2057	3304	103	3407	-1350	19	1917	573	63	-25
5	64	573	1500	2073	3367	98	3465	-1392	12	1929	594	64	-69
6	65	594	1271	1865	3491	104	3595	-1730	20	2498	650	65	98
7	66	650	1467	2117	3835	99	3934	-1817	29	2498	673	66	-21
8	67	673	1291	2192	3974	95	4069	-1877	0	2782	573	67	332
9	68	573	1519	2092	3359	107	3466	-1374	0	1945	578	68	-7
10	69	578	1269	1792	3403	95	3498	-1706	0	2220	669	69	-155
11	70	669	1516	2185	3947	99	4046	-1861	0	2835	727	70	247
12	71	727	1728	2455	4299	100	4399	-1944	0	2591	770	71	-123
13	72	770	1617	2387	4556	100	4656	-2269	0	3040	824	72	-53
14	73	824	1837	2661	4887	100	4987	-2326	0	3180	858	73	-4
15	74	858	1884	2742	5090	100	5190	-2448	0	3489	876	74	165
16	75	876	1933	2809	5200	100	5300	-2491	0	3588	886	75	211
17	76	886	1960	2646	5520	100	6020	-3174	0	3956	.	76	.

BALANCE SHEET: THE REMAINDER OF AFRICA 22:25 FRIDAY, DECEMBER 7, 1979 11

OBS	YR	CIRAF	PDNRAF	SUPRAF	DURAF	BALRAF	EXPRAF	IMPRAF	CORAF	YR1	ERRAF
1	60	948	4200	5148	5929	-781	172	1706	950	60	-197
2	61	950	2863	3813	5944	-2131	76	2581	1020	61	-646
3	62	1020	4394	5414	6380	-966	205	1869	1079	62	-381
4	63	1079	5606	6685	6749	-64	201	1533	1090	63	178
5	64	1090	5100	6190	6816	-626	88	1971	1180	64	77
6	65	1180	5229	6409	7380	-971	130	2152	1316	65	-265
7	66	1316	4433	5749	8228	-2479	104	4502	1393	66	526
8	67	1393	5281	6674	8712	-2038	65	3493	1535	67	-145
9	68	1535	7081	8616	9598	-982	151	2695	1472	68	90
10	69	1472	6186	7658	9207	-1549	105	2420	1647	69	-881
11	70	1647	6884	8531	10298	-1767	77	3665	1787	70	34
12	71	1787	7172	8959	11178	-2219	9	4175	1719	71	228
13	72	1719	8283	10002	10748	-746	309	3707	1796	72	856
14	73	1796	7063	8859	11234	-2375	511	5146	1843	73	417
15	74	1843	6616	8459	11525	-3066	59	5161	2015	74	21
16	75	2015	7167	9182	12601	-3419	44	5552	2022	75	67
17	76	2022	8640	10662	12648	-1986	204	5789	.	76	.

OBS	YR	CIIN	PDNIN	SUPIN	FOODIN	FEEDIN	SEEDIN	DMDIN	BALIN	IMPIN	EXPIN	COIN	YR1	ERIN
1	60	2525	10252	12777	12682	128	1327	14137	-1360	3826	0	2875	60	-409
2	61	2875	10992	13867	12614	128	1383	14125	-258	2872	0	3000	61	-386
3	62	3000	12040	15040	13605	128	1397	15130	-90	3876	0	3350	62	436
4	63	3350	10829	14179	14664	128	1381	16173	-1994	4276	0	2425	63	-143
5	64	2425	9861	12286	15384	166	1377	16927	-4641	5741	0	2225	64	-1125
6	65	2225	12291	14516	16956	166	1295	18417	-3901	7645	0	2975	65	769
7	66	2975	10424	13399	17422	137	1313	18872	-5473	6344	0	2300	66	-1429
8	67	2300	11392	13692	16430	199	1534	18163	-4471	6697	0	2700	67	-474
9	68	2700	16539	19239	18046	223	1633	19902	-663	3563	0	3925	68	-1025
10	69	3925	18651	22576	19853	242	1701	21796	780	3031	0	4250	69	-439
11	70	4250	20039	24289	20247	286	1866	22399	1890	2377	0	3500	70	767
12	71	3500	23833	27333	22339	318	2086	24743	2590	1553	230	6500	71	-2587
13	72	6500	26410	32910	26462	297	1969	28728	4182	1000	442	4450	72	290
14	73	4450	24735	29185	27130	297	1969	29396	-211	3571	0	2725	73	635
15	74	2725	22073	24798	25077	251	1720	27048	-2250	5392	0	3275	74	-133
16	75	3275	24235	27510	25711	289	1904	27904	-394	6427	0	6875	75	-842
17	76	6875	28846	35721	25811	346	2279	28436	7285	3859	0	.	76	.

OBS	YR	CIJ	PDNJ	SUPJ	FOODJ	FEEDJ	SEEDJ	DMDJ	BALJ	IMPJ	EXPJ	COJ	YR1	ERJ
1	60	650	1532	2182	3125	468	40	3633	-1451	2834	52	775	60	556
2	61	775	1780	2555	3207	616	43	3866	-1311	2773	84	1080	61	298
3	62	1080	1630	2710	3253	646	38	3937	-1227	2663	84	900	62	452
4	63	900	716	1616	3404	520	31	3955	-2339	3919	68	1000	63	512
5	64	1000	1244	2244	3593	534	27	4154	-1910	3546	80	1000	64	556
6	65	1000	1287	2287	3700	530	26	4256	-1969	3553	134	975	65	475
7	66	975	1023	1998	4025	543	22	4590	-2592	4260	77	1215	66	376
8	67	1215	969	2184	4106	592	24	4722	-2538	4028	122	1050	67	318
9	68	1050	1012	2062	4119	567	22	4708	-2646	3544	83	1000	68	-185
10	69	1000	759	1759	4168	667	17	4852	-3093	4425	56	860	69	416
11	70	860	474	1334	4092	701	11	4804	-3470	4834	35	950	70	379
12	71	950	440	1390	4169	632	9	4810	-3420	4965	43	1000	71	502
13	72	1000	284	1284	4250	713	6	4969	-3685	5486	49	1170	72	582
14	73	1170	202	1372	4316	708	5	5029	-3657	5353	30	1110	73	556
15	74	1110	232	1342	4409	619	8	5036	-3694	5404	31	1150	74	529
16	75	1150	241	1391	4522	590	9	5121	-3730	5923	38	1200	75	955
17	76	1200	222	1422	4521	590	8	5119	-3697	5522	38	.	76	.

BALANCE SHEET: THE REMAINDER OF ASIA 22:25 FRIDAY, DECEMBER 7, 1979 18

OBS	YR	CIRAS	PDNRAS	SUPRAS	DURAS	BALRAS	IMPRAS	EXPRAS	CORAS	YR1	ERRAS
1	60	2512	19216	21728	23878	-2150	5870	88	2498	60	1134
2	61	2498	18628	21126	23743	-2617	5985	156	2644	61	568
3	62	2644	21330	23974	25134	-1160	6161	396	2671	62	1934
4	63	2671	22155	24826	25394	-568	6165	287	2811	63	2499
5	64	2811	20795	23606	26723	-3117	6313	408	2798	64	-10
6	65	2798	21022	23820	26595	-2775	5762	147	2947	65	-107
7	66	2947	23153	26100	28010	-1910	7087	233	3168	66	1776
8	67	3168	25739	28907	30115	-1208	7449	138	3434	67	2669
9	68	3434	27149	30583	32645	-2062	8005	364	3742	68	1837
10	69	3742	28050	31832	35567	-3735	10089	264	3791	69	2299
11	70	3791	27687	31478	36038	-4560	11344	40	3885	70	2859
12	71	3885	29427	33312	36935	-3623	12110	128	4295	71	4064
13	72	4295	32506	36801	40832	-4031	12637	1167	4185	72	3254
14	73	4185	28263	32448	39787	-7339	13659	157	4315	73	1848
15	74	4315	30395	34710	41014	-6304	15815	25	4462	74	5024
16	75	4462	34824	39286	42417	-3131	11752	5	4621	75	3995
17	76	4621	38832	43453	43929	-476	16519	290	.	76	.

BALANCE SHEET: BRAZIL 22:25 FRIDAY, DECEMBER 7, 1979 20

OBS	YR	CIB	PDNB	SUPB	FOODB	FEEDB	SEEDB	DMDB	BALB	IMPB	COB	YR1	ERB
1	60	200	354	554	2053	451	106	2610	-2056	2011	200	60	-245
2	61	200	275	475	2033	488	75	2596	-2121	2283	200	61	-38
3	62	200	302	502	1968	516	80	2564	-2062	2402	200	62	140
4	63	200	136	336	2024	390	33	2447	-2111	1910	275	63	-476
5	64	275	256	531	2036	486	36	2558	-2027	2292	346	64	-81
6	65	346	237	583	1850	488	35	2373	-1790	2321	407	65	124
7	66	407	199	606	2043	778	46	2867	-2261	2637	496	66	-120
8	67	496	365	861	2071	584	78	2733	-1872	2485	602	67	11
9	68	602	699	1301	2236	630	119	2985	-1684	2425	681	68	60
10	69	681	1100	1781	2268	640	174	3082	-1301	2081	628	69	152
11	70	628	1731	2359	2523	711	215	3449	-1090	1855	444	70	321
12	71	444	2028	2472	2366	667	166	3199	-727	1475	223	71	525
13	72	223	680	903	2634	734	152	3520	-2617	2950	136	72	197
14	73	136	1800	1936	2924	824	218	3966	-2030	2440	285	73	125
15	74	285	2500	2785	3232	556	287	2813	-28	1663	422	74	1213
16	75	422	1510	1932	3689	680	154	3847	-1915	3755	376	75	1464
17	76	376	3120	3496	4125	680	318	4707	-1211	3504	.	76	.

BALANCE SHEET: ARGENTINA 22:25 FRIDAY, DECEMBER 7, 1979 21

OBS	YR	CIAR	PDNAR	SUPAR	FOODAR	FEEDAR	SEEDAR	DMDAR	BALAR	IMPAR	EXPAR	COAR	YR1	ERAR
1	60	1289	3960	5249	2906	135	548	4148	1101	0	1946	942	60	-1787
2	61	942	5100	6042	2902	134	449	4001	2041	0	2352	460	61	-771
3	62	460	5021	5481	2906	136	741	4267	1214	0	1806	395	62	-987
4	63	395	8940	9335	2910	141	801	4303	5032	0	2777	1501	63	754
5	64	1501	11240	12741	3009	145	601	3990	8751	0	4443	2870	64	1438
6	65	2870	6080	8950	3109	142	681	4170	4780	0	7948	1494	65	-4662
7	66	1494	6246	7740	3184	148	759	4323	3417	0	3059	460	66	-102
8	67	460	7321	7781	3281	164	762	4424	3357	0	1370	690	67	1297
9	68	690	5740	6430	3231	154	678	4407	2023	0	2785	603	68	-1365
10	69	603	7019	7622	3343	166	483	4349	3273	527	2108	584	69	1108
11	70	584	4921	5505	3623	93	561	4305	1200	0	1704	719	70	-1223
12	71	719	5680	6399	3693	29	515	4320	2079	0	1328	565	71	186
13	72	565	7901	8466	3609	44	426	4153	4313	0	3510	247	72	556
14	73	247	6560	6807	3549	51	570	4343	2464	493	1106	631	73	1220
15	74	631	5970	6601	3633	138	720	4876	1725	0	2178	845	74	-1298
16	75	845	8570	9415	3897	526	930	5353	4062	0	3111	730	75	221
17	76	730	11000	11730	3774	645	600	5019	6711	0	5584	.	76	.

BALANCE SHEET: THE REMAINDER OF LATIN AMERICA AND THE CARIBBEAN 22
22:25 FRIDAY, DECEMBER 7, 1979

OBS	YR	CIRSA	PDNRSA	SUPRSA	DURSA	BALRSA	EXPRSA	IMPRSA	CORSA	YR1	ERRSA
1	60	320	3309	2406	4936	-584	4	1209	313	60	308
2	61	313	3873	2738	5226	-183	8	1437	317	61	929
3	62	317	4266	3094	5462	134	4	1308	306	62	1132
4	63	306	3523	2030	5688	-827	55	1570	329	63	359
5	64	329	4027	2533	6063	-543	13	1738	375	64	807
6	65	375	4104	2858	6772	-642	142	1929	394	65	751
7	66	394	3825	2449	6792	-1230	78	2243	378	66	557
8	67	378	3947	2192	6832	-1341	1	2754	374	67	1038
9	68	374	3910	2435	6766	-1058	46	2345	386	68	855
10	69	386	4295	2467	7268	-1136	30	2222	408	69	648
11	70	408	4243	2456	7524	-1352	20	2485	419	70	694
12	71	419	4141	2511	7943	-1402	0	2665	439	71	824
13	72	439	3159	1758	8149	-2346	1	3222	443	72	432
14	73	443	3773	2083	8403	-2056	0	3512	429	73	1027
15	74	429	4223	2659	8465	-1346	50	3090	437	74	1257
16	75	437	4378	2157	8756	-1929	50	3133	516	75	638
17	76	516	5487	2596	9068	-1647	70	3257	.	76	.

BALANCE SHEET: AUSTRALIA 22:25 FRIDAY, DECEMBER 7, 1979 17

OBS	YR	CIAU	PDNAU	SUPAU	FOODAU	FEEDAU	SEEDAU	DMDAU	BALAU	EXPAU	COAU	YR1	ERAU
1	60	1703	7449	9152	1232	400	384	2016	7136	4999	1078	60	1059
2	61	1078	6728	7806	1308	359	431	2098	5708	6277	569	61	-1138
3	62	569	8352	8921	1258	272	431	1961	6960	4788	572	62	1600
4	63	572	8927	9499	1238	248	469	1955	7544	7813	583	63	-852
5	64	583	10037	10620	1225	327	459	2011	8609	6469	617	64	1523
6	65	617	7068	7685	1303	781	545	2629	5056	5681	541	65	-1166
7	66	541	12699	13240	1156	413	588	2157	11083	6984	1467	66	2632
8	67	1467	7547	9014	1255	671	702	2628	6386	7011	1731	67	-2356
9	68	1731	14805	16536	1241	286	714	2241	14295	5369	4818	68	4108
10	69	4818	10546	15364	1274	321	419	2014	13350	7250	7234	69	-1134
11	70	7234	7890	15124	1285	395	462	2142	12982	9492	4993	70	-1503
12	71	4993	8510	13503	1276	534	544	2354	11149	8736	2263	71	150
13	72	2263	6442	8705	1272	934	620	2826	5879	5562	886	72	-569
14	73	886	12094	12980	1408	911	506	2825	10155	5509	1300	73	3346
15	74	1300	11500	12800	1389	1000	529	2918	9882	8049	1751	74	82
16	75	1751	11980	13731	1354	628	539	2521	11210	8072	2251	75	887
17	76	2251	11713	13964	1316	380	621	2317	11647	8357	.	76	.

BALANCE SHEET: THE REMAINDER OF OCEANIA 22:25 FRIDAY, DECEMBER 7, 1979 18

OBS	YR	CIROC	PDNROC	SUPROC	DUROC	BALROC	EXPROC	IMPROC	COROC	YR1	ERROC
1	60	66	251	317	289	28	0	240	125	60	143
2	61	125	172	297	397	-100	0	260	113	61	47
3	62	113	248	361	439	-78	0	260	105	62	77
4	63	105	273	378	443	-65	0	300	113	63	122
5	64	113	263	376	418	-42	0	330	111	64	177
6	65	111	332	443	446	-3	0	290	106	65	181
7	66	106	301	407	462	-55	0	195	92	66	48
8	67	92	453	545	493	52	0	140	89	67	103
9	68	89	395	484	419	65	31	80	101	68	13
10	69	101	254	355	207	148	124	100	72	69	52
11	70	72	310	382	390	-8	0	215	89	70	118
12	71	89	390	479	446	33	0	180	78	71	135
13	72	78	358	436	400	36	0	143	56	72	123
14	73	56	206	262	389	-127	0	185	25	73	33
15	74	25	0	25	337	-312	0	252	41	74	-101
16	75	41	420	461	345	116	0	217	66	75	267
17	76	66	387	453	395	58	14	133	.	76	.

BALANCE SHEET: THE SOVIET UNION 22:25 FRIDAY, DECEMBER 7, 1979 26

OBS	YR	PDNCCP	DUCCP	NDNDCCP	INPCCP	EXPCCP	ESCOCCP	YR1
1	60	64300	58864	5436	204	5058	582	60
2	61	66500	64384	2116	0	5052	-2936	61
3	62	70800	63276	7524	0	5330	2194	62
4	63	49700	55779	-6079	8859	1282	1498	63
5	64	74400	62424	11976	2656	1159	13473	64
6	65	59700	74804	-15104	9187	2201	-8118	65
7	66	100500	75194	25306	4683	4126	25863	66
8	67	77300	77633	-333	1534	5084	-3883	67
9	68	93400	84779	8621	147	5397	3371	68
10	69	79900	89623	-9723	1105	5887	-14505	69
11	70	99700	99015	685	315	7072	-6072	70
12	71	98800	98374	426	3409	5478	-1643	71
13	72	85600	99593	-13793	15000	1303	-96	72
14	73	109700	100230	9470	4389	5035	8824	73
15	74	83900	89349	-5449	2934	4000	-6515	74
16	75	66200	81644	-15444	10096	1000	-6348	75
17	76	96900	92482	4418	4559	1400	7577	76

BALANCE SHEET: THE PEOPLE'S REPUBLIC OF CHINA 22:25 FRIDAY, DECEMBER 7, 1979 27

OBS	YR	PDNPRC	CUPRC	NDNDPRC	INPPRC	ESCOPRC	YR1
1	60	21000	22907	-1907	1980	73	60
2	61	16000	20811	-4811	4746	-65	61
3	62	21000	25303	-4303	4871	568	62
4	63	22000	27545	-5545	5198	-347	63
5	64	25000	30177	-5177	5046	-131	64
6	65	26000	32578	-6578	6325	-253	65
7	66	26000	31595	-5595	5124	-471	66
8	67	28000	31053	-3053	4156	1103	67
9	68	27000	28716	-1716	3563	1847	68
10	69	25000	31394	-2394	5040	2646	69
11	70	31000	32458	-1458	3660	2202	70
12	71	33000	31403	1597	2967	4564	71
13	72	35000	36885	-1885	5289	3404	72
14	73	36000	35790	210	5831	6041	73
15	74	37000	38195	-1195	5675	4480	74
16	75	41000	36450	4550	2287	6837	75
17	76	43000	47000	-4000	0	-4000	76

BALANCE SHEET: EASTERN EUROPE 22:25 FRIDAY, DECEMBER 7, 1979 9

OBS	YR	CIEEU	PDNEEU	SUPEEU	DUEEU	BALEEU	IMPEEU	EXPEEU	COEEU	YR1	EREEU
1	60	2492	12500	15392	18597	-3205	4818	101	2386	60	-874
2	61	2386	13600	15986	17805	-1819	4520	240	2580	61	-119
3	62	2580	13500	16480	19256	-2776	4692	51	2474	62	-609
4	63	2474	13400	15874	18462	-2588	5999	495	2817	63	99
5	64	2817	14400	17217	21025	-3808	5198	87	2882	64	-1579
6	65	2882	18600	21482	21509	-27	5373	597	2821	65	1928
7	66	2821	18100	20921	21055	-134	5051	1053	3104	66	760
8	67	3104	20700	23804	23162	642	4287	1652	3075	67	202
9	68	3075	20600	23675	22945	730	4065	917	3177	68	701
10	69	3177	20700	23877	23711	166	4476	505	3274	69	863
11	70	3274	19200	22474	24432	-1958	5778	249	3991	70	-420
12	71	3991	24600	28591	29784	-1193	4985	566	3936	71	-710
13	72	3936	25800	29736	29375	361	3592	910	3924	72	-881
14	73	3924	26800	30724	29285	1439	4707	1836	4060	73	250
15	74	4060	27800	31860	30297	1563	3682	1201	3863	74	181
16	75	3863	24000	27863	28828	-965	4119	1865	4347	75	-3058
17	76	4347	28600	32947	32438	509	5900	1200	.	76	.

BALANCE SHEET: CANADA 22:25 FRIDAY, DECEMBER 7, 1979 25

OBS	YR	CIC	PDNC	SUPC	FOODC	FEEDC	SEEDC	DMDC	BALC	EXPC	COC	YR1	ERC
1	60	16291	14108	30399	1509	1721	578	4208	26191	9307	16524	60	360
2	61	16524	7713	24237	1582	1199	1027	3808	20429	9938	11134	61	-643
3	62	11134	15393	26527	1420	1207	1064	3691	22836	9015	13042	62	779
4	63	13042	19690	32732	1588	1470	1145	4203	28529	15088	12567	63	874
5	64	12567	16349	28916	1554	1250	1091	3895	25021	11909	13841	64	-729
6	65	13841	17674	31515	1639	1421	1142	4202	27313	14833	11645	65	835
7	66	11645	22516	34161	1606	1459	1099	4164	29997	14833	15341	66	-177
8	67	15341	16137	31478	1647	1794	1072	4513	26965	8902	17911	67	152
9	68	17911	17686	35597	1690	1227	910	3827	31770	8700	22760	68	310
10	69	22760	18623	41383	1758	2694	457	4909	36474	8999	27096	69	379
11	70	27096	9022	36118	1755	2168	710	4633	31485	11561	20604	70	-680
12	71	20604	14122	34726	1775	2213	778	4766	29960	13716	16229	71	15
13	72	16229	14514	30743	1760	2045	890	4695	26048	15648	10440	72	-40
14	73	10440	16460	26900	1818	1915	795	4528	22372	11737	10076	73	559
15	74	10076	14200	24276	1904	1699	906	4509	19767	11168	8208	74	391
16	75	8208	17078	25286	1917	1770	1059	4746	20540	12136	7984	75	420
17	76	7984	23587	31571	1824	1990	922	4736	26835	12904	.	76	.

OBS	YR	CIUS	PDNUS	SUPUS	FGODUS	FEEDUS	SEECUS	DMDUS	BALUS	IMPUS	EXPUS	COUS	YR1	ERUS
1	60	35748	36869	72617	13308	163	1747	15218	57399	221	17986	38406	60	1228
2	61	38406	33539	71945	13472	980	1535	15987	55958	158	19536	35975	61	605
3	62	35975	29718	65693	13281	2096	1671	17048	48645	140	17332	32529	62	-1076
4	63	32529	31211	63740	13581	816	1769	16166	47574	112	23099	24532	63	55
5	64	24532	34928	59460	13744	463	1785	15992	43468	23	19607	22242	64	1642
6	65	22242	35805	58047	13934	3429	1685	19048	38999	15	23398	14565	65	1051
7	66	14565	35514	50079	13817	3293	2134	19244	30835	35	19978	11551	66	-659
8	67	11551	41030	52581	14129	1851	1946	17926	34655	21	20198	14657	67	-179
9	68	14657	42365	57022	14145	3347	1668	19160	37862	13	14693	22226	68	956
10	69	22226	39263	61489	14168	4763	1546	20477	41012	71	16480	24086	69	517
11	70	24086	36783	60869	14139	5144	1720	21003	39866	7	19821	19894	70	158
12	71	19894	44029	63923	14315	6640	1720	22675	41248	7	16907	23487	71	861
13	72	23487	42046	65533	14370	7158	1807	23335	42198	2	31992	11920	72	-1712
14	73	11920	46407	58327	14370	4166	2288	20824	37503	80	31068	6722	73	-207
15	74	6722	48807	55529	14288	1252	2504	18044	37485	10	28325	8899	74	271
16	75	8899	57764	66663	15213	2585	2068	19866	46797	25	31522	18098	75	-2798
17	76	18098	58306	76404	15050	2900	2400	20350	56054	36	26395	.	76	.

APPENDIX C

THE VALUES OF VARIABLES USED IN CHAPTERS V AND VI

Variable Names	Units	Mean	1976 Value	Projected 1985 Value
PD^F	mmt	270.0	359.0	390.4
YLD^F	mt/ha	1.48	1.82	2.01
PD^{US}	mmt	40.8	58.3	65.4
YR	last two digits of year	68	76	85
FO^{US}	mmt	14.2	16.0	17.8
Y^{US}	$/person	3212	5511	10581
SE^{US}	mmt	1.9	2.5	2.8
APL^{US}	mha	24.0	32.5	b
DU^F	mmt	283.0	349.3	a
PW^F	$/mt	100.0	145	a
POPW	m. people	3510	4104	4816
CO^F	mmt	42.2	62.7[c]	a
CI^F	mmt	43.2	44.3	43.2
FE^{US}	mmt	2.8	1.9	a
PW^{US}	$/bu	2.03	2.85	a
LVN^{US}	m. animal units	76.4	74.7	72.6
PC^{US}	$/bu	1.16	1.77	1.84
CO^{US}	mmt	20.6	30.3	a
CI^{US}	mmt	21.5	18.1	21.5
EX^{US}	mmt	22.3	26.4	a

A definition of these variables can be found in Table XXII.

[a]1985 values are not given for endogenous variables.

[b]The 1985 value of APL^{US} is not used to project SE^{US} since the result would be inconsistent with projected PD^{US}. A ratio of SE^{US} to PD^{US} is used to project SE^{US}.

[c]Approximate.

VITA

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