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Abstract

Chinese import demand for wheat may have important effects on the world wheat market. To analyze these effects, the present analysis incorporates policy-based criteria to generate a plausible range of import trends for China. The analysis also incorporates nutritional requirements and age composition to project alternative Chinese import patterns. These projections are then subjected to random shocks and used to assess the impact of stochastic Chinese trade on the world wheat market. The analysis uses an econometric model of the world wheat market in a projections mode to generate values of world trade and price for 1980-89 under alternative Chinese import scenarios. The model incorporates dynamic adjustments to trade in major trading regions as well as endogenous policy responses to world market conditons. The results demonstrate that the differential impact of Chinese imports under three alternative import scenarios is substantial. In particular, the level and variability of world trade and price increase as Chinese import demand rises. The implications to policymakers are important. If China's trend share in the world wheat market continues to rise, the likelihood is that traders will face higher and more variable prices.

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China's increasing wheat imports have important implications for the world wheat market and for major wheat traders. While China's imports averaged only 5 million metric tons (MMT) in the period 1961-76, imports rose to 14 MMT in 1980. Grain agreements with Argentina, Canada, and the United States for the next three years total 11-16 MMT. China's wheat imports increased from 5 percent to 15 percent of the world market between 1960 and 1980.

Wheat is the world's major traded foodgrain. In 1980/81, 94 MMT of wheat were traded compared to 13 MMT of rice. Annual variations in the trade behavior of a single major importing or exporting country can have a significant impact on world prices as well as on the production, consumption and trade behavior of other countries in the market. Variability in wheat supplies and prices is a problem particularly for countries which depend heavily on the world market to make up domestic food deficits and for countries whose farm income and export revenues are highly dependent on wheat exports. In 1980/81, wheat was the third largest U.S. agricultural export in terms of value and accounted for

nearly 20 percent of all U.S. agricultural exports and over $8 billion in foreign exchange earnings.

In the period between 1960 and 1980, the industrial nations' share of total wheat trade declined relative to that of the less-developed and centrally-planned economies. This shifted a larger proportion of total trade toward countries with greater production variability. In addition, market rigidities have been rising due to the greater role of state trading agencies and other trade restrictions, notably in centrally-planned countries and the European Economic Community. China's future role in the world wheat market is a major concern to world producers and consumers, especially in low income countries, particularly since it is demonstrable that recent rises in the import shares of centrally-planned economies is associated with increased variability in the market (see, e.g., Blandford and Schwartz, Bain).

The potential effects of future Chinese wheat imports on world wheat prices and trade in the 1980s are assessed here through stochastic simulations of an econometric model of world wheat trade. Projections for China's wheat demand are difficult to make because statistics on grain production, grain consumption and income growth are scarce and of questionable quality. Further, government policy plays a heavy role in import decisions, and government policies have shifted frequently. This analysis focuses on the impact of Chinese policy on imports. The scenarios used for the simulations are based on a simple model which expresses Chinese imports as a function of three factors: production, consumption policy and nutritional requirements.

These projections are subjected to random shocks and used to assess the impact of stochastic Chinese trade on the world wheat market. The analysis uses an econometric model of the world wheat market in a projections mode to generate values of annual world trade and price for 1980-89 under alternative Chinese import scenarios. The model is dynamic and nonlinear. It contains 25 equations and is estimated over crop years 1960/61 and 1979/80. Submodels are built for the U.S. and Canada, the two largest exporters, so that considerable information can be obtained about how their production, consumption, stocks and trade interact with the world market. For other traders, the model solves for net trade only.

The model takes into account that domestic support policies and restrictive trade practices of major trading nations have important effects on world price. Endogenous effects of major exporter policies are incorporated. Certain importers, especially those which are highly dependent on the world market for their food supply, are precautionary buyers. Their imports will become more inelastic or even rise when world supplies tighten. The model incorporates the endogenous policy effects of precautionary buyers as well as the effects of other importers' restrictive trade practices. The import scenarios and model used for the analysis are described below, followed by a discussion of the simulation results.

Chinese Import Scenarios

This analysis assumes that China will meet foodgrain deficits by importing exclusively wheat. In fact, import behavior in recent years

has supported this assumption. China has also imported small amounts of corn and exported small amounts of rice. Hence wheat imports have tended to represent total net grain imports. This pattern of grain trade appears to reflect the lower world prices of wheat relative to rice, and the preference of wheat to corn in the Chinese diet.

The projections of Chinese wheat imports used here differ from the projections of other researchers (e.g., Tang and Stone) in several respects. Two key concepts are developed here to evaluate Chinese import needs. First, to maintain a constant calorie intake relative to nutritional requirements, consumption of grain must grow as fast as the rate of adult equivalent unit growth. This rate, which accounts for the changing age structure, will be faster than population growth if the birth rate is trending downward. The growth of the adult equivalent population and consumption relative to nutritional requirements, (referred to as "per adult equivalent" grain consumption) are used in projections of total grain consumption. These are analogous to the conventionally used population growth and per capita consumption but contain more information. In general the growth of per adult equivalent grain consumption in China has been a function of government policy rather than income.

The second key concept is the differentiation between urban and rural needs. Imports are used to attain urban grain consumption requirements which are not met by government grain procurement from the rural sector. In creating the projections, urban and rural consumption needs are considered separately and then linked through government policy. Under a given production level, higher rural consumption targets will

tend to be associated with lower procurement for urban consumption. For a given urban consumption target, the lower procurement level will necessitate higher wheat imports.

Domestic output growth also affects import needs. Assumed growth rates of production reflect the success or failure of government plants to increase agricultural input availability and productivity.

To represent the consumption and production factors which appear to influence import decisions, the following formula was used to make projections

$$M_t = (1+r_{up}+r_{uc})^t(38)-[(1+r_g)^t(320)-(1+r_{rp}-r_{rc})^t(294)]$$

where M_t is the level of wheat imports in year t

r_{up} is the growth rate of urban population[1/]

r_{uc} is the growth rate of urban per equivalent consumption

r_g is the growth rate in domestic grain production

r_{rp} is the growth rate of rural population

r_{rc} is the growth rate of rural per equivalent consumption.

The 1980 base levels of urban consumption, total domestic grain production and rural consumption were 38, 320 and 294 million metric tons, respectively. The formula relies on the assumption that net grain imports fill the gap between urban consumption needs and procurement levels.

The assumed growth rates used in the projection formula for the three scenarios are listed in Table 1. More detailed information on the assumptions and rates contained in Schwartz and Ralston. The import requirements corresponding to rates in Table 1 are summarized in Table 2. Starting with the 1980 import level of 11.7 MMT, trend imports rise under

Table 1. Assumed Growth Rates In Chinese Import Scenarios[a/]

	Scenario I	Scenario II	Scenario III
	Percent		
Grain Production Growth			
1980-85	2.0	2.5	2.9
1985-89	2.0	2.5	2.9
Rural Equivalent Unit Growth			
1980-85	1.76	2.11	2.27
1985-89	1.11	1.42	1.64
Urban Equivalent Unit Growth			
1980-85	1.2	1.2	1.2
1985-90	1.0	1.0	1.0
Rural Per Equiv. Consumption Growth			
1980-85	0.35	0.5	0.9
1985-89	1.0	1.0	1.53
Urban Per Equiv. Consumption Growth			
1980-85	0.5	0.75	1.0
1985-89	0.7	1.0	1.1

a/ See text for explanation of equivalent units and "per equivalent" consumption growth.

Source: Ralston

Table 2. Projections of Chinese Import Levels for Wheat, 1980-89

	Scenario I	Scenario II	Scenario III
		MMT	
1980	11.7	11.7	11.7
1981	12.5	12.2	12.6
1982	13.5	12.7	13.5
1983	14.4	13.3	14.4
1984	15.5	13.8	15.5
1985	16.6	14.4	16.6
1986	14.9	15.0	17.8
1987	13.4	15.6	19.1
1988	12.1	16.3	20.5
1989	10.9	17.0	22.0

Scenario I to 17 MMT in 1985 and fall back to 11 MMT by 1989 (due principally to a fall in adult equivalent nutritional requirements after 1984). Scenario I assumes government policies which could successfully restrict population growth and consumption but which could sacrifice grain production growth. This scenario might well describe a return to the conservative policies used from 1965 to 1976. The other two scenarios assume that imports would continue to grow at the rate established over 1980-85. In these scenarios, as the equivalent unit growth rate declines, per equivalent consumption is assumed to increase to maintain constant growth in consumption. Scenario II assumes medium growth rates for grain production and nutrition requirements due to population changes. This scenario would be the result of policies which return to somewhat stronger central authority over production and population. Surls and Tuan cite this as a possibility. Under Scenario II imports trend up to 17 MMT by 1989. The third scenario assumes a combination of events which would lead to continued growth in Chinese wheat imports to 22 million metric tons in 1989. Import requirements of this magnitude could result from relaxed policies leading to high production growth rates which are more than offset by higher per equivalent consumption.

There are several factors suggesting that China's imports will be dominated by more consistent trend behavior and smaller residual variation than in the past. Relative political stability at present is likely to make import behavior depend more heavily on trends in population, income, domestic grain production and availability of foreign exchange. Since 1977, import variability around an upward trend has been

fairly low, about 8 percent. Since even under a more stable political structure policy shifts seem inevitable during the next decade, a 10 percent standard deviation was chosen for use in the stochastic simulations. Percentage, rather than absolute, variation in imports is assumed because of strong trends in the underlying factors affecting imports.

Model of World Net Wheat Trade

A dynamic nonlinear econometric model of world wheat trade is used to assess China's impact on world trade and prices. The model contains 25 equations, including 20 behavioral equations and 5 identities. The model is annual, estimated over crop years 1960/61 to 1979/80.

The five major exporting countries and regions, which currently account for over 90 percent of world wheat exports, are modeled individually. Included were the U.S., Canada, Australia, Argentina and the European Community of Nine (EC9). For the two major wheat exporters, the U.S. and Canada, submodels of domestic production, consumption, end-year stocks and net exports are constructed. For the other exporters, net trade equations are estimated.

Imports of wheat are much less concentrated than exports. Net trade equations are estimated for the most important importing countries and regions. Japan, India, Poland and Brazil are individually estimated.[2/] Since the model was estimated over 1960/61-79/80, Pakistan and Bangladesh are estimated as a single region. The other major import regions can be classified into three groups: countries which are essentially nonproducers of wheat (Group 1), countries whose import variability depends mainly on domestic production fluctuations (Group 2), and countries with rapidly rising incomes and demand which produce some wheat

and which in recent years have become more dependent on the world market to meet their food demand (Group 3).[3/] Smaller importers are geographically aggregated (Other South America, Other Asia, Other Africa). Soviet and Chinese imports are considered as exogenous.

Individual equations and their regression statistics are presented in Schwartz. A principal feature of the model is the incorporation of endogenous policy effects. The model recognizes that domestic support programs and restrictive trade practices have important effects on the world price. Domestic policies of the major exporters have large effects particularly because the export market is highly concentrated. For the U.S., Canada and Australia, the effects of domestic support policies are manifest in large part through domestic stock levels which adjust either to stabilize domestic prices or to maintain a floor price for farmers. At low prices, stocks are more price elastic and are accumulated as floor prices are approached (e.g., when U.S. farmers default on their loans). These support policies are linked to trade since rather than flooding the world market, the surplus is held in storage to keep domestic and world prices from falling below a floor level.

The import equations reflect the fact that most importers have some degree of restrictive trade practices, ranging from tariffs to monopoly marketing boards. In general imports are modeled as a function of real income, population, foreign exchange availability, domestic production, policy responses and price. Countries whose policies seek to maintain stable consumption regardless of changes in domestic production or world price will tend to increase world price variability (see, e.g.,

Schwartz). Certain importers, particularly those which are highly dependent on the world market for much of their food supply, tend to have policies which ensure food security. These countries tend to have more inelastic demand, or may actually increase imports at high prices, when world market supplies are tight. In the model, Poland and Groups 1 and 3 behave in this manner. Other regions are not price-responsive (Brazil, Pakistan and Bangladesh, Japan, China, the USSR, Group 2, and Other South America). Certain regions, particularly poorer LDCs, reduce imports and tend to be more price elastic when world prices are high (India, Other Africa and Other Asia).

The model solves for the level of annual trade in each region and country in addition to U.S. and Canadian stocks, production and consumption. Additionally, it solves for the equilibrium world price at which the sum of net exports of the model's export sector equals the sum net imports in the model's import sector.

The model was estimated using ordinary least squares.[4/] All the estimated equations conform to theoretical logic and satisfied criteria for goodness of fit and correctness of signs. The estimated coefficients generally have high precision (low standard errors relative to estimated coefficients). The performance of the model was validated by a historical simulation. The criteria used included root mean square error (MSE), Theil decomposition of the MSE, Theil U2 statistics, turning point analysis and percentage root mean square error (PMSE). For world price, out of 19 periods, there were two missed turning point errors and two falsely predicted turning points. The PMSE is only 12 percent. The

performance of other endogenous variables was generally better than for price. The full results are presented in Schwartz.

To simulate the model over 1980 to 1989, trend projections were made for all non-price exogenous variables in the model, based on historical compound growth rates.[5/] Deflators and other price variables were held so that the price results from the model are in 1979 constant dollars.

Simulation Results

(1) Methodology

To analyze the impact of Chinese imports on variability in the world market, stochastic simulation was used. Each of the alternative scenarios presented in Table 2 was simulated over 1980 to 1989 assuming random Chinese import variability of 10 percent. For each of the three scenarios, 50 ten-year simulations were performed. In each run, a different random value for Chinese imports for each of the ten years was generated. These values were taken from a random normal distribution corresponding to the assumed standard deviation of 10 percent of trend imports. One of the interesting features of the analysis is the TROLL program written for the simulation recorded the 50 sets of random numbers drawn for Scenario I and reused the same sets for Scenarios II and III. The analysis, therefore, examined how the same set of shocks cause different trade and price effects under alternative assumptions about Chinese import behavior. It should be noted that the same percentage shocks will corresponds to different absolute shocks in each scenario.

Deterministic simulations were run to establish nonstochastic levels of world trade and price under each of the scenarios presented in Table 2. A base run holding Chinese imports constant at their actual 1980 level was also performed to provide a point of reference. (It is cited as the "base" in the results.)

Since the differences among the simulations tend to be the greatest in 1989, much of the discussion focuses on that year. In each year, the means and absolute variability of endogenous variables change across scenarios. To make the results across years easier to compare, the coefficient of variation, which measures relative variability, is recorded along with the mean for all endogenous variables. Under the assumptions of the analysis, only Chinese imports vary stochastically. The coefficients of variations measure partial, not total, variability of prices and trade. The coefficients of variation indicate the percentage of variability about trend trade and prices due only to Chinese import variability (and to the responses of the other traders to Chinese import variability). The reported means indicate the different levels of expected prices and trade under alternative Chinese import paths. Since each scenario starts with the same initial condition of 11.7 MMT of Chinese imports, first year price and trade was the same in each case.

It should be noted that references to "trend" values in the discussion below are the results evaluated when the exogenous values of the model are held at projected trend values. They do not refer to the more commonly-used definition of the results of a fitted trendline.

Table 3. Level and Relative Variability of Real World Wheat Price and Trade Associated with Alternative Chinese Import Paths, Selected Years

	Scenario I	Scenario II	Scenario III
Mean		$/MT	
Price			
1980	161	161	161
1983	158	154	159
1986	166	159	174
1989	143	168	204
World Trade		MMT	
1980	72.1	72.1	72.1
1983	78.7	77.7	78.7
1986	83.4	84.0	86.3
1989	85.9	91.2	95.2
Coefficient of Variation		Percent	
Price			
1980	2.1	2.1	2.1
1983	3.0	2.7	3.0
1986	3.7	3.4	4.3
1989	1.8	3.5	5.6
World Trade			
1980	1.5	1.5	1.5
1983	1.3	1.2	1.3
1986	1.6	1.6	1.9
1989	1.2	1.8	2.2

(2) World Trade and Price

Expected price in 1980 is $161/MT (Table 3). World price under constant Chinese imports of 11.7 MMT falls over the projection period from $161/MT in 1980 to $143/MT in 1989, assuming all other traders follow their trend paths. Under Scenario I, world price rises from $161/MT to $166/MT in 1986 and falls back to $143/MT by 1989. In Scenario II, where Chinese imports rise at a constant rate from 11.7 to 17 MMT, world price is $159/MMT in 1986 and $168/MT in 1989.[3/] In Scenario III, where the highest growth in trend Chinese imports is assumed, trend world price rises to $147/MT by 1986 and $204/MT by 1989. Under the assumption of constant Chinese imports, China's trend share of net world wheat imports falls from 16 to 14 percent by 1989. Under Scenario I, it rises from 16 to 20 percent by 1986 and then falls to 13 percent in 1989. Under II it rises to 19 percent in 1989; in Scenario III, to 23 percent. Expected net world exports under constant Chinese trade rise from 72 MMT in 1980 to 87 MMT in 1989. In Scenario I, they rise to 83 MMT in 1986 and 86 MMT in 1989. For the same years, net exports are 84 MMT and 91 MMT in II; and 86 and 95 MMT in Scenario III.

All three scenarios start off with the same variability (due to the same level and variability of Chinese imports), but by 1989, the percentage variability of prices differs substantially. Relative price variability is 1.8 percent in Scenario I, 3.5 percent in Scenario II and 5.6 percent in Scenario III. Relative variability of world exports also increases over the same period but by smaller proportions.

Table 4. Chinese Import Costs, Mean and Coefficient of Variation

	Scenario I	Scenario II	Scenario III
Mean	- - - - - - -	$ Billion - - - - - - -	
1980	1.88	1.88	1.88
1983	2.28	2.04	2.28
1986	2.44	2.35	3.07
1989	1.55	2.86	4.49
Coefficient of Variation	- - - - - - - -	Percent - - - - - - -	
1980	12.1	12.1	12.1
1983	13.0	12.7	13.0
1986	13.7	13.4	14.3
1989	11.8	13.5	15.6

(3) Chinese Import Costs

The path which Chinese imports take have a dramatic effect on their real cost and variability of their cost. Mean Chinese import costs are $1.88 billion in 1980 and vary an average of 13 percent (Table 4). In Scenario III, costs exceed $3 billion by 1986, rising to $4.49 billion in 1989. The variability of Chinese import costs increases with price. In 1989, Chinese import costs are 30 percent more variable under Scenario II than under Scenario I. Chinese import cost variability always exceeds import variability.

(4) Net Exporter Results

Table 5 contains the simulated results for the values of major traders' net exports and export revenues in selected years. The difference between 1989 mean world net exports in Scenario I and III is 9.3 MMT, 60 percent of which is comprised of increases in U.S. net exports in Scenario III. The relative variability of U.S. exports ranges from a 1989 value of 1.4 percent in Scenario I to 3.0 percent in Scenario III. It more than doubles over the period in Scenario III, even though 1989 trend U.S. exports are only 14 percent higher in Scenario III than in Scenario I. U.S. export revenues average $5.03 billion in 1980. Mean revenues in 1989 in Scenario III ($9.29 billion) are nearly 60 percent higher than in Scenario I ($5.7 billion). Since exports and price tend to move in the same direction, U.S. export revenues vary considerably. In Scenario III, the variability in U.S. export revenues attributable to Chinese import variability is as high as 8 percent in 1989.

Table 5. Net Exporters' Trade and Export Revenues and Revenues, Selected Years

	Scenario I	Scenario II	Scenario III
	MMT		
Mean			
U.S. Net Exports			
1980	31.18	31.18	31.18
1983	36.30	35.70	36.30
1986	38.80	38.99	40.43
1989	39.92	42.88	45.52
Canada Net Exports			
1980	17.97	17.97	17.97
1983	18.55	18.27	18.55
1986	17.81	18.29	18.79
1989	16.83	18.28	19.00
Australia Net Exports			
1980	11.72	11.72	11.72
1983	10.66	10.59	10.66
1986	11.10	11.04	11.14
1989	10.90	11.52	11.61
EC9 Net Exports			
1980	6.51	6.51	6.51
1983	7.75	7.70	7.75
1986	9.58	9.35	9.58
1989	10.88	11.16	11.70
Argentina Net Exports			
1980	2.7	2.7	2.7
1983	3.1	3.1	3.1
1986	3.8	3.8	3.8
1989	4.3	4.3	4.3
	Percent		
Coefficient of Variation			
U.S. Net Exports			
1980	2.1	2.1	2.1
1983	1.7	2.4	1.3
1986	2.2	2.2	2.5
1989	1.4	2.3	3.0
Canada Net Exports			
1980	2.3	2.3	2.3
1983	2.0	1.9	2.0
1986	2.8	2.7	3.2
1989	2.4	3.6	4.2
Australia Net Exports			
1980	0.2	0.2	0.2
1983	0.5	0.8	0.5
1986	0.4	0.5	0.3
1989	2.5	0.3	0.1
EC9 Net Exports			
1980	0.0	0.0	0.0
1983	1.2	1.1	1.2
1986	1.1	0.9	1.1
1989	0.7	1.1	1.7
Argentina Net Exports			
1980	0.0	0.0	0.0
1983	0.0	0.0	0.0
1986	0.0	0.0	0.0
1989	0.0	0.0	0.0

	Scenario I	Scenario II	Scenario III
	$ Billions		
Mean			
U.S. Net Export Revenues			
1980	5.03	5.03	5.03
1983	5.75	5.49	5.76
1986	6.43	6.19	7.06
1989	5.70	7.22	9.29
Canada Export Revenues			
1980	2.90	2.90	2.90
1983	2.94	2.81	2.94
1986	2.95	2.90	3.28
1989	2.40	3.08	3.87
Australia Export Revenues			
19802	1.89	1.89	1.89
1983	1.69	1.63	1.69
1986	1.84	1.75	1.94
1989	1.56	1.94	2.37
EC9 Export Revenues			
1980	1.05	1.05	1.05
1983	1.23	1.18	1.23
1986	1.59	1.48	1.67
1989	1.55	1.88	2.38
Argentina Export Revenues			
1980	0.43	0.43	0.43
1983	0.50	0.48	0.50
1986	0.61	0.58	0.64
1989	0.61	0.72	0.87
	Percent		
Coefficient of Variation			
U.S. Net Export Revenues			
1980	4.3	4.3	4.3
1983	4.3	3.9	4.3
1986	5.5	5.2	6.5
1989	2.8	5.4	7.9
Canada Export Revenues			
1980	4.4	4.4	4.4
1983	4.1	3.7	4.1
1986	5.8	5.5	6.8
1989	3.3	6.1	8.4
Australia Export Revenues			
1980	2.3	2.3	2.3
1983	3.5	3.4	3.5
1986	4.0	3.9	4.6
1989	4.2	3.8	5.7
EC9 Export Revenues			
1980	2.1	2.1	2.1
1983	4.1	3.7	4.1
1986	4.6	4.0	5.1
1989	2.3	4.2	6.6
Argentina Export Revenues			
1980	2.1	2.1	2.1
1983	3.0	2.7	3.0
1986	3.7	3.4	4.3
1989	1.8	3.5	5.6

Canadian wheat exports tend to be a declining share of world trade. The maximum growth in trend exports within scenarios is just over 1 MMT. Between scenarios, the maximum difference in the size of Canadian exports occurs in 1989 between Scenario I (16.8 MMT) and Scenario III (19 MMT). This translates into a difference of 13 percent, compared to 14 percent in the U.S. results. Canadian exports vary relatively more than their U.S. counterparts. Relative export variability in Canada is 2.3 percent in 1980, nearly 10 percent higher than in the U.S. In 1989, the mean Canadian export earnings are 60 percent higher in Scenario I than in Scenario II, similar to the percentage increase in U.S. exports. The relative variability of export revenues tends to be slightly higher than the U.S.

Trade and the relative variability of trade are lower in Australia, the EC9 and Argentina than in the U.S. and Canada (Table 5). Australian exports do not rise much in the simulation. Initially, exports drop to 10.4 MMT in 1981 in each scenario. They rise by 1.2 MMT or less in each Scenario by 1989. Export variability is generally under 1 percent, indicating the low price responsiveness of Australian exports. The relative variability of exports is small, always under 2 percent. EC9 export revenues are much lower than Australia's before 1988, but as EC9 trend exports rise, by 1989 their earnings are about the same as Australia. The relative variability of EC9 export earnings tends to be about 1 percentage point higher than world price variability. Argentina is not a price-responsive exporter. There is no variability in Argentinian exports attributable to Chinese import demand shocks. The relative variability of Argentinian export revenues is identical to the variability in price.[7/]

(5) Net Importers

Table 6 presents the trend net imports and import costs of the major non-price-responsive net importers: Japan, Pakistan and Bangladesh, the USSR, Brazil, Group 2 importers, and Other South America. Net exports are rising in each of these countries. Since none of these traders is price-responsive, trend imports do not vary with Chinese imports and are, therefore, the same across scenarios in a given year. Equally, Chinese import shocks do not cause imports to vary. However, Chinese trade and trade variability affect the cost of imports in these countries. If Chinese imports follow Scenario III, imports of non-price-responsive countries cost an average of 20 percent more in 1989 than under Scenario II assumptions and 43 percent more than under Scenario I. This difference is due only to price differences across scenarios (because trend imports do not vary across scenarios).

The variability of import costs for all non-price-responsive traders is the same as that for world price. The explanation is identical to that given for Argentina. Import cost relative variability, therefore, tends to rise with price and by 1989 is over three times as high under Scenario III assumptions than under Scenario I. Relative variability is nearly twice as high under Scenario II than under I.

The precautionary importers tend to have more inelastic or even increased demand as prices rise to extreme values. The largest precautionary buyers are composed of Group 1 and Group 3 traders. Group 1 (nonproducers) net imports rise on trend in all three scenarios (Table 7). As world price rises, import demand becomes more inelastic. Mean net imports rise to nearly 9.8 MMT in Scenario I, but 1989 imports are 4

Table 6. Trend Imports and Mean Import Costs of Major Non-price-responsive Importers

	Trend Net Imports[a]	Mean Net Import Costs		
		Scenario I	Scenario II	Scenario III
	- MMT -	- - - - - $ Billions - - - - -		
Japan				
1980	5.40	0.87	0.87	0.87
1983	5.58	0.90	0.87	0.90
1986	5.99	0.99	0.95	1.04
1989	6.34	0.91	1.07	1.29
Pakistan and Bangladesh				
1980	3.56	0.57	0.57	0.57
1983	4.06	0.64	0.62	0.64
1986	4.61	0.76	0.73	0.80
1989	5.19	0.74	0.87	1.06
USSR				
1980	8.08	1.30	1.30	1.30
1983	8.32	1.32	1.28	1.32
1986	8.58	1.42	1.36	1.50
1989	8.84	1.26	1.49	1.80
Group 2				
1980	3.07	0.49	0.49	0.49
1983	3.27	0.52	0.50	0.52
1986	3.52	0.58	0.56	0.61
1989	3.84	0.55	0.65	0.78
Brazil				
1980	4.61	0.74	0.74	0.74
1983	5.13	0.81	0.79	0.81
1986	5.69	0.94	0.90	0.99
1989	6.31	0.90	1.06	1.28
Other South America				
1980	1.52	0.25	0.25	0.25
1983	1.70	0.27	0.26	0.27
1986	1.88	0.31	0.30	0.33
1989	2.09	0.30	0.35	0.43

a Price-invariant and, therefore, the same imports hold for all scenarios.

Table 7. Other Net Importers' Trade and Import Costs, Selected Years

	Scenario I	Scenario II	Scenario III	Scenario I	Scenario II	Scenario III
	MMT			$ Billions		
Mean						
Group 1 Net Imports				Group 1 Import Costs		
1980	6.38	6.38	6.38	1980	1.03	1.03	1.03
1983	7.37	7.45	7.37	1983	1.17	1.14	1.17
1986	8.28	8.39	8.16	1986	1.37	1.33	1.42
1989	9.76	9.34	8.91	1989	1.39	1.57	1.81
Group 3 Net Imports				Group 3 Import Costs			
1980	10.44	10.44	10.44	1980	1.68	1.68	1.68
1983	11.85	11.84	11.85	1983	1.88	1.82	1.88
1986	13.24	13.27	13.30	1986	2.19	2.11	2.32
1989	14.71	14.80	14.86	1989	2.10	2.49	3.03
India Net Imports[a]				India Export Revenues			
1980	-1.21	-1.21	-1.21	1980	0.19	0.19	0.19
1983	-1.06	-0.98	-1.07	1983	0.17	0.15	0.17
1986	-1.05	-0.95	-1.19	1986	0.18	0.15	0.21
1989	-0.56	-0.96	-1.52	1989	0.08	0.16	0.31
Poland Net Imports				Poland Import Costs			
1980	2.82	2.82	2.82	1980	0.46	0.46	0.46
1983	2.04	2.03	2.04	1983	0.32	0.31	0.32
1986	1.89	1.88	1.91	1986	0.31	0.30	0.33
1989	1.67	1.72	1.80	1989	0.24	0.29	0.37
Other Asia Net Imports				Other Asia Import Costs			
1980	1.87	1.87	1.87	1980	0.30	0.30	0.30
1983	2.08	2.09	2.08	1983	0.33	0.32	0.33
1986	2.20	2.24	2.20	1986	0.36	0.36	0.38
1989	2.42	2.37	2.28	1989	0.35	0.40	0.47
Other Africa Net Imports				Other Africa Import Costs			
1980	2.08	2.08	2.08	1980	0.34	0.34	0.34
1983	2.12	2.21	2.12	1983	0.34	0.33	0.34
1986	2.36	2.37	2.34	1986	0.39	0.38	0.41
1989	2.66	2.61	2.54	1989	0.38	0.44	0.52
	Percent			Percent		
Coefficient of Variation				Coefficient of Variation		
Group 1 Net Imports				Group 1 Import Costs		
1980	0.8	0.8	0.8	1980	1.3	1.3	1.3
1983	1.0	0.9	1.0	1983	2.0	1.8	2.0
1986	1.1	1.0	1.3	1986	2.6	2.3	3.0
1989	0.5	0.9	1.3	1989	1.3	2.6	4.3
Group 3 Net Imports				Group 3 Import Costs			
1980	0.2	0.2	0.2	1980	2.3	2.3	2.3
1983	0.2	0.2	0.2	1983	3.1	2.8	3.1
1986	0.2	0.2	0.3	1986	3.8	3.5	4.5
1989	0.2	0.3	0.5	1989	1.8	3.4	6.0
India Net Imports				India Export Revenues			
1980	4.3	4.3	4.3	1980	6.5	6.5	6.5
1983	7.1	6.7	7.1	1983	10.2	9.4	10.2
1986	9.1	8.8	10.0	1986	12.8	12.2	14.2
1989	7.3	9.7	11.8	1989	9.0	13.1	17.4
Poland Net Imports				Poland Import Costs			
1980	0.2	0.2	0.2	1980	2.3	2.3	2.3
1983	0.4	0.4	0.5	1983	3.5	3.1	3.5
1986	0.6	0.5	0.8	1986	4.3	3.9	5.1
1989	0.3	0.7	1.6	1989	2.1	4.2	7.2
Other Asia Net Imports				Other Asia Import Costs			
1980	0.0	0.0	0.0	1980	2.1	2.1	2.1
1983	0.8	0.7	0.8	1983	2.4	2.2	2.4
1986	0.8	0.6	0.8	1986	3.2	3.0	3.8
1989	0.5	0.8	1.5	1989	1.6	3.2	5.1
Other Africa Net Imports				Other Africa Import Costs			
1980	0.3	0.3	0.3	1980	1.7	1.7	1.7
1983	0.4	0.4	0.4	1983	2.6	2.4	2.6
1986	0.4	0.4	0.6	1986	3.2	2.9	3.7
1989	0.2	0.4	0.8	1989	1.6	3.1	4.8

[a] Negative net imports are net exports.

percent less in Scenario II and nearly 9 percent less in Scenario III. The relative variability of imports is under 1.5 percent. Unlike Group 1, Group 3 net importers (structural change) eat mainly wheat and do not tend to reduce consumption when world prices rise. Their wheat imports rise when world price increases as a hedge against the possibility of future price escalations. Import variability is 0.5 percent or less annually.

Table 7 also includes results for Poland (a precautionary buyer), Other Asia and Other Africa (price-responsive buyers), and India, which is a price-responsive buyer but a trend net exporter throughout the projection period. As expected, Other Asia and Africa reduce imports at price extremes. Their import costs tend to vary slightly less than world price. The variability of Poland's net imports falls in between Groups 2 and 3 although its import cost variability tends to be higher than the other precautionary buyers. India's net exports are price-responsive and vary between a mean of 0.6 and 1.5 MMT. The relative variability of Indian net exports and export revenues is the highest for any trader, although in absolute terms the variability is small.

Interpretation of the Results

Relative price variability does not rise simply because absolute Chinese import variability increases with trend, i.e., because percentage variability remains constant. Looking at 1989 only, when the difference among the scenarios is the greatest, trend imports in China are 11 MMT in Scenario I, 17 MMT in II, and 22 MMT in Scenario III. A major shock of, say, 2 standard deviations (20 percent) would increase Chinese trade by

an additional 2.2 MMT in I, 3.4 MMT in II, and 4.4 MMT in III, for a maximum difference of 2.2 MMT of imports over trend between Scenarios I and III. A single major shock in 1989 is less than 5 percent of world net exports, which range from 84 to 99 MMT in 1989 across all the scenarios. In contrast, the calculated relative price variability over all sizes of market shocks in Scenario III three times that of I in 1989. Part of the explanation for the increased price variability has to do with market behavior of traders other than China at high world prices. In Scenario III, the 1989 mean real price is 43 percent higher than in I. At the price extreme of III, exporting countries are nearing minimum working stock levels and are less willing to export additional surplus. Food-security conscious buyers are making purchases to ensure domestic supplies in the face of a tight world market. At the same time, the non-price-responsive importers -- including China -- sustain their import levels regardless of high prices, and the adjustments by price-responsive buyers are relatively small. In Scenario I, large surplus stocks overhang the market, low prices prevail, and the food security of other importers is not threatened.

The price effect cannot be easily decomposed into the contribution to price variability due directly to Chinese imports and the contribution due to the induced systematic resonses of other traders. Certain general comments can be made, however, about the induced trade effects. Trend rises in EC9 and Argentinian wheat exports in the face of declining world demand help to depress world price in Scenario I; but as demand increases, especially in III, the rise in these exports keeps prices from increasing further. On the other hand, these exporters are less price

responsive than either Canada, Australia, or the United States. Growth in the EC9 and Argentinian market shares, therefore, adds to price instability in the world wheat market.

The trend share of non-price-responsive buyers (excluding China) falls in each scenario, especially III. When China is included, their combined total is 69 percent in 1980. The combined 1989 trade share is 64 percent in Scenario I, compared to 67 percent in Scenario II, and nearly 70 percent in Scenario III. The less price-responsive the market is, the higher the expected price variability unless compensating stabilizing changes occur in the price-responsive sectors of the world market. The mean of Group 1 net trade declines as world price increases. However, the other precautionary buyers actually increase their average net imports in Scenario III compared to Scenario I. It is clear, however, that the nature of the price responses of precautionary buyers is potentially more destabilizing than that for other traders.

Some compensating behavior in the market is apparent. The stocks and exports of the U.S. and Canada are the prime stabilizing factors. Much of the market adjustment takes place through changes in U.S. and Canadian stock levels. Mean stocks in the U.S. rise from 29 MMT in 1980 to nearly 40 MMT in Scenario I in 1989 to absorb the drop in Chinese imports. In Scenario II, stocks level off at 35 MMT in 1989 and 30 MMT in Scenario III. Similar percentage drops occur in Canada. At the same time, between 1980 and 1989, mean U.S. net exports rise from 31 MMT to 40 MMT in Scenario I, 43 MMT in Scenario II, and 46 MMT in Scenario III. Canadian exports do not rise as strongly. There are also some smaller compensating effects due to the price-responsive behavior of U.S.

consumption, Australian and Indian net exports, and the net imports of Other Africa and Other Asia and, to some extent, Group 1 buyers.

In 1989, world net export variability under the high growth scenario is nearly double Scenario I. When China follows a low growth import trend, its expected share of the world market in 1989 is 13 percent. When China follows the high growth trend, its expected share is 23 percent. Since its share of the market in Scenario III is about 75 percent higher than in Scenario I, it is clear that the responses of other market traders are responsible for part of the near doubling of world net trade variability. However, the low fraction of the increase due to other traders indicates the inelastic nature of world trade responses.

Conclusions

Chinese wheat imports have varied considerably since 1961. The potential for dramatic increases was demonstrated when Chinese wheat imports nearly tripled between 1976 and 1980 to 14 MMT. This increase suggests that understanding China's potential role in the world wheat market is now of critical importance to the world's major wheat exporters as well as to other wheat traders whose availability of supplies and whose import costs may be affected by Chinese import decisions. The current study has demonstrated that even when Chinese imports are the only random factor in the world market, the impact on world price and world price variability is substantial.

Little is known about what the path of Chinese imports is likely to be throughout the 1980's. The projections used in this study assume that

wheat imports fill the gap between urban consumption targets and net procurement of grain. The results of stochastic simulations of the world wheat trade model demonstrate that the differential impact of Chinese imports under alternative import scenarios is significant.

The 1980-89 Chinese imports scenarios used in this study represent a range from low to high in which the extremes were less than 11 MMT apart both across time and across scenarios. The range of Chinese trend trade, between 13 percent and 23 percent of world net imports, equivalent to 11 MMT, is fairly conservative. Nevertheless, this maximum difference of 11 MMT in trend Chinese imports increases the expected value of world price by over 40 percent, and more than triples relative price variability. Moreover, most of this effect emerges in the short period between 1985 and 1989.

The difference in the results is due to China's following alternative policies which lead either to low import growth or to much higher import needs. The plausibility of the assumed extremes and, in fact, their conservative nature serve to underscore the need for policymakers to be aware of the potential impact of China on the world wheat market. The results highlight the importance of a careful monitoring by Chinese leaders relative to population, income and the use of foreign exchange. The price disruptions in the world wheat market experienced in the mid 1970's could be reexperienced unless precautions are taken.

The projected increase in wheat price and price variability is likely to cause the same problems for China as for other wheat importers. China does not appear to be a price-responsive wheat importer. A high import growth policy could find costs of wheat imports rising rapidly.

If high imports are maintained, either pressure to increase urban consumer prices will rise or severe strains on the government budget due to higher subsidy expenditures will result. The alternative to increasing imports is either to allow slower growth in urban consumption, rural consumption, or both. Because recent Chinese policies favoring rural diversification, industrialization and cash crop production rely on lower grain procurement responsibilities, interests of rural grain consumers are gaining importance relative to urban consumers. Thus, the Chinese government could be faced with increasingly difficult tradeoffs between improved rural living standards, low urban food prices, food subsidy expenditures, and import costs. Their decisions, in turn, will have significant ramifications for other major wheat traders.

FOOTNOTES

1/ Detailed population projections are complicated because for a given fertility rate and life expectancy, birth and death rates will change annually as the age structure changes (Banister, 1977). While a 10-year average population growth rate would distort the true year to year change in nutritional requirements, the use of distinct growth rates each year was too cumbersome. Therefore, the population growth rates were averaged over two periods, 1980-85 and 1985-89 to allow for the impact of changing age structure.

2/ India was a net importer for most of the historical period over which the model was estimated. However, since the late 1970's India has been an occasional net exporter. In the simulation over 1980-89, India is a small trend net exporter.

3/ Group 1 includes Indonesia, Nigeria, Phillippines, S. Korea and Venezuela. Group 2 is Jordan, Mexico, Morocco, Spain, Syria, Tunisia and Yugoslavia; Group 3, Chile, Colombia, Egypt, Iraq, Saudi Arabia, Algeria and Portugal.

4/ In most cases, hypothesis tests for autocorrelation were negative. The remaining few were in the inconclusive range. It was decided not to correct for autocorrelation in the cases where the hypothesis tests were inconclusive.

5/ These growth rates were taken from semilog time regressions for 1960-1979. If the estimated trend rate was deemed unlikely to continue, the results were adjusted to reasonable values. The procedures and rates used are in Schwartz and Ralston.

6/ Prices drop from their initial 1980 values as the model moves from historical lagged values at the start of the simulation period to trend values during the projection period.

7/ If exports are Q_t and price is P_t, and exports do not vary randomly, then the variance of earnings ($Q_t \cdot P_t$) in a given year is ($E(Q_t)^2$) $\cdot$ var (P_t). It follows that the coefficient of variation is ($\bar{Q}t \cdot$ standard deviation (P_t)/ ($\bar{Q}_t \cdot \bar{P}_t$), where $\bar{Q}$, $\bar{P}$ are mean values. This reduces to (standard deviation (P_t)/$\bar{P}_t$), i.e., export revenue has the same relative variability as prices when exports do not vary stochastically.

APPENDIX

DATA AND DATA SOURCES

Industrial country data on acreage, yield, production, stocks, consumption, imports and exports were taken from USDA sources: the Oasis Databank and various issues of the FAS Reference Tables on Wheat, Corn, Total Coarse Grains Supply-Distribution for Individual Countries. Population, income, foreign exchange earnings, and price indices were taken from the IMF International Financial Statistics Yearbook, 1980. To create composite income and foreign exchange earnings, variables for the aggregates in the model, individual country data were converted to a common currency (the U.S. dollar) using foreign exchange conversion rates published in the IMF International Financial Statistics. Wheat export prices are taken from USDA Wheat Situation, various issues; corn export prices from IBRD Commodity Trade and Price Trends, 1980. Wheat and corn threshold prices in the European Community are taken from USDA Foreign Agriculture Circular, Grains, FG-42-81 and Gallagher.

At the time of estimation, the Colombian export earnings series only existed up to 1977. A semilog time trend was fitted to the available series (1960-77). Two years (1978 and 1979) were extrapolated from the fitted time trend. The full series was then combined into the aggregate earnings for countries with structural change (GROUP3_EXVDB). Because

the Colombian series exhibited a strong time trend ($R^2 = .97$), the extrapolation was considered to be acceptable.

Although all the data are taken from well-known sources, it should be recognized that the same variable may have different values depending on who collected the data. For example, Paulino and Tseng have done a comparison of FAO and USDA series on food staples data. It is worth noting that they conclude that cereals tend to have fewer discrepancies than other foods.

Other data series, such as population, are estimates by the United Nations which have become the standard data used. Additional explanatory notes about the series used are contained in the cited sources.

The analysis of Chinese grain consumption and imports draws on data for Chinese population, income, grain consumption and grain production. Data on birth rates and population growth rates are taken from compilations by Aird (1980), Coale and Banister (1981). Grain consumption data are taken from compilations by Lardy (1982a), and Smil. Data on livestock production were taken from compilations of Chinese reports by Stone and Weins (1980). Grain production and import data were taken from USDA, Agricultural Situation: People's Republic of China (1981, 1982). Income data were taken from the Chinese Agricultural Year Computation Commission Agricultural Yearbook of China 1980, and IBRD (1981). Additional statistics on price indices, savings rates, depreciation rates and foreign exchange earnings were also taken from IBRD (1981).

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