The Former Soviet Union and the World Wheat Economy

James R. Jones, Shuangling Li, and Stephen Devadoss*

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* Professor, Research Assistant, and Assistant Professor, respectively, Department of Agricultural Economics and Rural Sociology, University of Idaho.

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Introduction

Wheat import demands of the former Soviet Union (FSU) greatly influenced the volume of wheat trade and prices after the Soviets entered into the world wheat market as a consistent, but variable, buyer in the seventies and eighties. Wheat imports, which typically have accounted for half of the former Soviet Union's grain imports, peaked in 1984 at approximately 25% of global wheat trade. The world food economy is confronted with a new era following the collapse of central planning and single-party communism in the former Soviet republics. Arguments that the former Soviet Republics may cease or reverse their role as a continuous deficit region have been reviewed. The purpose of this study is to evaluate the impacts of the former Soviet Union's withdrawing from the world wheat market on world trade and prices and to analyze the effects of random fluctuations in FSU's wheat production on the world wheat market. While the simulated impact on average price levels is significant, price trends at the turn of the century are shown to depend on other economic parameters. The stochastic simulation suggests that the former Soviet region will play a moderately important role in the year-to-year behavior of the world wheat economy even if long-term self-sufficiency is achieved.

Economic Transition and Former Soviet Wheat Trade

Raup, a long-time observer of Soviet agriculture, has noted on several occasions that the Soviets should be able to eliminate their need for imports, and more recently he has speculated that this is "well within their grasp, and it could come relatively quickly ... by the latter years of the 1990s." Studies by U.S.D.A. researchers (Cook, Leifert, and

Koopman; Sheffield; Koopman) suggest that under full privatization, marketization, and liberalization of agriculture, the former Soviet Union could approach self-sufficiency or even become a net exporter of grain, and particularly wheat. Other analysts are joining the chorus that the former Soviet Union could discontinue its presence as a major buyer in the world wheat market by the end of this century (e.g., Avery 1992; Brooks 1992).

D. Gale Johnson (1992) recently noted that when and to what extent the former Soviet Republics will reverse their role as a major grain importer is highly speculative. We concur. It is now apparent to analysts that it is impractical to expect the transition to a market-oriented economy to occur overnight. Prices and quantities were far from their likely equilibrium values in the old regimes (Hewett 1989). Changing from a planned economy with heavily subsidized consumer prices and irrational input and output prices has proven to be a daunting undertaking. Reform programs have had limited positive impact partly because of a deeply ingrained distrust of markets and partly because the basic superstructure of highly bureaucratized and monopolized systems remains entrenched. Where the old bureaucratic system of economic management is being dismantled, a lack of progression toward operational market mechanisms still pervades the scene. The fallout includes "near universal corruption" (Foster 1991) that goes beyond the frustrations and inconvenience of encounters with red tape. Several observers of Soviet agriculture have noted that after several years as wage earners, farm workers still lack managerial and entrepreneurial traditions (e.g. see Guth 1990). Macroeconomic price discipline has been delayed, with alarming inflationary results. Social and political instability continues in the former Soviet Republics. Viability of the economy will require fashioning of institutional arrangements (Bromley 1993).

It is difficult enough that history has to be reversed, but in addition, with no historical precedent to draw on except the Eastern European experience, economists have an overwhelming task in offering solutions to politicians who will dominate the process that restructures socialism into market-driven economies. Political leaders in the former centrally planned economies aspire to achieve capitalism's efficiencies without abandoning other goals long espoused by socialists. Whether one takes the Schumpeterian perspective (Murrell 1990), stressing innovation over security when contrasting capitalist and Soviet-type economies, or efficiency versus equity (Hewett 1988), politicians have a challenging job converting these economies to market-oriented western-type economies. Russia has made more progress in developing markets and private property than any other member of the Commonwealth of Independent States. Nevertheless, in spite of Yeltsin's endorsement and relative success in achieving rapid price and economic reform, the outcome of the December 1993 elections cannot be regarded as promising for future reforms (Vanous 1993). Pressures to backtrack almost inevitably will slow the transition. Alexander Nikonov, an eminent Russian agricultural economist, has stated it will take almost a decade to travel the road of transition. This may be an optimistic estimate.

Timing is one speculative dimension of the former Soviet Union's future role in the world wheat economy, and the extent that its wheat deficit is reduced or reversed is the other dimension that invites speculation. Agricultural land in the former Soviet Union is relatively abundant, even if poor soils and weather conditions are taken into account (OECD 1991, p. 98). Imperial Russia was one of the world's major surplus grain producers before becoming a casualty to the First World War, which evolved into revolution and civil war. Grain shipped through Odessa and other Black Sea ports constituted about half of Russia's total export revenue towards the end of the nineteenth century (Charques, p. 37). However, to extrapolate a return to this status a century later just because the Marxist centrally planned economy has collapsed may be going too far.

In Czarist times, the sale of grain apparently took some 15% or more of total Russian production in spite of considerable hunger at home. Russia's land tenure and agricultural procurement system was possibly nearly as much export biased in the twilight of Czarist Russia as under Stalin in order to finance foreign investment and credits to support industrialization, and the military schemes of a totalitarian ruling regime. The Soviet Union's poor agricultural performance and large imports of grains in the last two decades were due to over-stimulated demand from price and income policies and other policy errors as much as systemic failure of agricultural production and distribution (Johnson and Brooks). Simply replacing socialized agriculture with privatized agriculture will not assure success of the region's wheat economy, especially if accompanied by poor financial and price management and policies. Besides, as current events attest, policies of intervention in market-oriented economies can bias trade towards exports or imports.

An infinite variety of scenarios for former Soviet participation in the world wheat economy by the turn of the century could emerge from the preceding observations. In the short to intermediate term, the former Soviet Union, as a region, could continue to be a net wheat importer if compensatory export credit guarantees and subsidies are available from western governments to finance those purchases (Jones, Sheffield). However, it is very plausible to conservatively speculate that if we assume that rather large concessional injections discontinue by the year 2000, the region will approach or be constrained to self-sufficiency. This paper makes the assumption (not prediction) that the Soviets will have exited the world grain market as a continuous net importer by the year 2000. A spatial world wheat trade model simulates this occurrence in the context of a market environment with much the same economic and policy climate that currently exists and compares this scenario with alternative trade and economic environments.

Base Model Specification and Description

The model from which simulations are reported in this paper draws from a spatial trade model and data sources reported in Qu (1992) and Li (1993). Spatial trade models are standard tools for analyzing patterns and trends in the world wheat market. The basic approach of spatial equilibrium models is to divide the world into regions and specify supply and demand equations for each region. Geographical centers of surplus production and consumption are selected and transportation costs between these points are estimated. The model consists of 11 exporting regions consisting of Australia, Argentina, the European Economic Community, and 8 U.S. and Canadian export ports, plus 23 foreign importing regions. See Appendix Table 1 for the listing of importing and exporting regions. An equilibrium set of prices, quantities, and trade flows is generated so as to maximize net social payoff or its equivalent net benefits of trade (e.g., see Takayama and Judge).

Excess demand functions defined as $Q_i = a_j - bp_j$, and excess supply functions as $Q_j = \alpha_i + \beta p_i$ specified in the price domain, convert to the quantity domain

$$P_j = \lambda_j - \omega_j Q_j \tag{1}$$

$$P_i = \mu_i + \eta_i Q_i \tag{2}$$

where $\lambda_j = a_j/b_j$, $\omega_j = 1/b_j$, $\mu_i = -\alpha_i/\beta_i$, $\eta_i = 1/\beta_i$

and

$Q_j = \sum_{i=1}^{n} X_{ij}$ is the sum of shipments to country j from exporting country i,

$Q_i = \sum_{j=1}^{m} X_{ij}$ is the sum of shipments from exporter i to importing country j.

The quantity domain formulation was incorporated into an objective function to maximize net social payoff (Z)

$$Z = \sum_{j=1}^{23} \int_{0}^{Q_j} (\lambda_j - \omega_j Q)dQ - \sum_{i=1}^{11} \int_{0}^{Qi} (\mu_i + \eta_i Q)dQ - \sum_{i}^{11} \sum_{j}^{23} T_{ij}X_{ij} \tag{3}$$

$$= \sum_{j=1}^{23} (a_j/b_j)Q_j - \frac{1}{2} \sum_{j=1}^{23} (1/b_j)(Q_j)^2 - \sum_{i=1}^{11} (-\alpha_i/\beta_i)Q_i$$

$$-\frac{1}{2} \sum_{i=1}^{11} (1/\beta_i)(Q_i)^2 - \sum_{i-1}^{11} \sum_{j=1}^{23} T_{ij}X_{ij}$$

subject to

(1) $Q_j = \sum_{i=1}^{11} X_{ij}, \quad j = 1......23$

(2) $Q_i = \sum_{j=1}^{23} X_{ij}, \quad i = 1......11$

(3) $P_j \geq 0$ and $P_i \geq 0$, $j = 1...23$, $i = 1...11$

(4) $X_{ij} \geq 0$, $i = 1......11$, $j = 1......23$

(5) $P_j - P_i \leq T_{ij}$, $i = 1......11$, $j = 1......23$,

where

- i represents export regions or ports, i = 1...11, and i = 1...8 represents U.S. and Canadian ports;
- j represents import countries or regions, j = 1...23;
- P_i represents the price of wheat at export ports i;
- P_j represents the price of wheat at import ports j;
- X_{ij} represents wheat trade flows from export ports to import ports;
- T_{ij} represents transportation costs per unit from export ports to import ports;

Z as defined earlier is net social payoff;

a_j represents the intercept of the excess demand function for j;

b_j represents the slope of the excess demand function for j;

α_i represents the intercept of the excess supply function i;

β_i represents the slope of the excess supply function for i;

Q_j represents the quantity of wheat imports;

Q_i represents the quantity of wheat exports.

Constraint equations (1) and (2) were introduced to meet import demand and export supply conditions in importing and exporting regions or countries, respectively. Constraint (3) assumes import and export prices at equilibrium are positive. Constraint (4) assumes that quantity outflows of wheat from export regions or inflows to import regions are greater than or equal to zero. Constraint (5) specifies no trade activity between importing and exporting countries if the price wedge or difference between these countries is less than ocean shipping cost.

For purposes of projecting and analyzing international trade flows and prices in the year 2000, parameters of excess supply and excess demand functions for a base period (1987-89) were estimated. Country price elasticities were used to derive parameter values for the major exporting and importing countries in the model. Estimated excess demand and supply functions are listed in Appendix Table I.

Ocean shipping rates were estimated using a procedure outlined by Qu (1992). Annual export quantity and price data for designated port areas in the U.S. were obtained from *Grain and Feed Market News* (1971-1991). Reference export and import prices were calculated from trade value and quantity data from *FAO Trade Yearbook* (1990). The quadratic programming model with linear constraints was solved by using the General Algebraic Modeling System (GAMS/MINOS) software package.

Trade flows and prices in the base year model solution are presented in Table 1. Total international shipments approximated 94 million metric tons in the base period solution. The U.S. and Canada together exported 48 million metric tons, about 50% of total world exports. China, the FSU, the Middle East, Egypt, and North Africa were major importers. Total imports by the FSU of about 14.8 million metric tons accounted for 16% of world total imports in the base simulation.

The significance of the Soviet role in world trade in the base period can be seen by running a scenario without its presence (Table 2). World trade volume drops approximately 7.5% and the trade weighted export price falls $27 per ton from $142 dollars per ton to $115 per ton, or approximately 19%. The model is specified so that regional impacts within North America can also be observed. While the price in the Pacific Northwest falls $21.5 per ton, it falls by $28.5 per ton in the Gulf of Mexico, reflecting the spatial relationship of the FSU to the two regions.

2000 Projection

This section presents the results of solutions which project the volume of wheat trade flows and prices at the turn of the next century. The purpose of this section is to provide some perspective on what the future world wheat market will be like if the former Soviet republics are no longer sustained net importers.

Population, income, and wheat production were projected to the year 2000 using the natural exponential function $V = A(1 + i)^t$ where the annual growth rate is denoted by i, the exponent t of the expression $(1 + i)$ denotes the number of periods covered in compounding, and A is a base number for beginning period value being projected. These projections are used to calculate parameters for excess supply and demand functions in the year 2000. The resulting excess supply and demand expressions are $Q_i = \alpha_i^{'} + \beta P_i$ and $Q_j = a_i^{'} - bP_j$.

Tables 3 and 4 present comparisons of the base period solution without the FSU with projected scenarios (global crisis and global shift) based upon population and income growth rates assumed in the OECD study, *Long-Term Prospects for the World Economy* (1992). The "global crisis" scenario is run assuming the world experiences an annual income growth rate of 2.6% annually and population growth of 1.5% through the turn of the century. The "global shift" scenario assumes the same population growth rate, but a higher gross domestic product growth rate of 3.4%. Projected growth rates averaging 2.3% for world wheat production were assumed in both scenarios. Assumptions by region are listed in Appendix Table II. The purpose of the projections is to give some perspective on the implications of Soviet withdrawal as a consistent year-to-year importer in the context of the dynamics of the world wheat market. Soviet withdrawal in conjunction with the lower income growth assumptions would result in prices falling by a magnitude similar to that of the base period comparison of Tables 1 and 2, but if income grows about 1% faster, wheat prices would be substantially higher even without the Soviets. Scenarios (not shown) using a 2.1% average growth assumption for world wheat production led to similar price and trade solutions.

Stochastic Disturbances in FSU Wheat Production

The focus of the discussion so far has been on the impact of the FSU's discontinuing its role as a consistent net importer in the world wheat market. However, even assuming long-term self-sufficiency, the region still may play a significant role in the world wheat market by buying wheat in years of crop shortfalls and selling in years of bumper crops. Because the grain belt in the former Soviet Union is located in the high northern latitudes, summers are short and winters long. Winterkill, for example, can be a factor contributing to annual crop variations. In addition, short growing seasons enhance the penalty of delays in planting and harvesting and therefore in year-to-year variations caused by weather phenomena such as drought, flood, adverse conditions at the time of harvest, and winterkill. In this section, a stochastic simulation analysis is employed to analyze the projected effects of stochastic wheat supply in the FSU on domestic and world price variability and trade flows.

Following Bigman (1982), we postulate a stylized model to examine the impact of the FSU wheat production instability. Consider a model with linear supply and demand functions defined for each region or country, i = 1, ... n as

$$S_i = a_i + b_i P_t + u_t \tag{4}$$

$$D_i = c_i - d_i P_t \tag{5}$$

where S is supply; D is demand; P is price, a, b, c, and d are positive coefficients; and u is stochastic supply disturbances. The stochastic term is assumed to be distributed with mean zero and variance σ^2. We assume that consumers' tastes and preferences are stable and domestic demand is not subject to random fluctuations. The stochastic disturbance vector $[u_1, u_2 ..., u_n]$ is distributed with mean $[\mu_1, \mu_2 ..., \mu_n]$ and variance $[\sigma_1^2, \sigma_2^2, ... \sigma_n^2]$. All covariance terms are assumed zero, implying that supply shifts in different countries are governed by independent forces. The linearity and additive risk assumptions simplify determination of market equilibrium in a multicountry world, because they generate linear excess demand/supply equations. Throughout this analysis, country 1 is assumed to be the former Soviet Union. Excess supply/demand for country i is given by

$$X_i = S_i - D_i = a_i + b_i P_{it} + u_{it} - c_i + d_i P_{it}. \tag{6}$$

As shown in Bigman, the degree of price variability in the FSU is reduced as a result of trade. Trade acts as a buffer program that helps to stabilize prices in the FSU. The issue addressed here is how stochastic supply in the FSU affects the world wheat market.

A stochastic simulation procedure is used to analyze the impacts of FSU wheat instability. The stochastic simulation procedure is based on the large-sample theory that the distribution of a sample approaches that of the true population as the sample size increases. Stochastic simulation is used to analyze the behavior of the endogenous variables in response to random shocks. For example, production fluctuations are due to random shocks generated by weather vagaries, pests, and disease[1]. These production fluctuations cause inherent instability in the market, and the stochastic simulation approach is an appropriate technique to study the effects of these instabilities on other endogenous variables. McCarthy (1982) has provided the methodology for undertaking stochastic simulations, which is briefly discussed next.

Consider the following definition of pseudo-structural disturbances:

$$V = \frac{1}{\sqrt{T}} rU \tag{7}$$

where V is a $1 \times M$ matrix of pseudo-structural disturbances; r is a $1 \times T$ vector of random numbers, normally distributed with zero means and unit variances; U is any $T \times M$ matrix of disturbances from T observations of M true structural equations, and has $M \times M$ covariance matrix $\Sigma = T^{-1}EU'U$. Since r is standard normal, and is independent of U, the covariance matrix of V is given by

$$\Sigma_V = EV'V = \frac{1}{T}[EU'U]I = \Sigma. \tag{8}$$

[1]Production would capture the stochastic elements better than yield because stochastic elements in production contain variability in both the yield and acreage.

Substitution of estimated sample residuals, $\hat{U}$, for U yields the disturbance vector and its covariance matrix:

$$\hat{V} = \frac{1}{\sqrt{T}} r \hat{U} \tag{9}$$

$$\hat{\Sigma}_v = \frac{1}{T} E \hat{U}' \hat{U} = \hat{\Sigma}. \tag{10}$$

In empirical application, however, $\hat{\Sigma}$ is estimated first, and $\hat{V}$ is computed using r as follows (see, Chowdhury and Heady 1980). Define

$$\hat{V} = Hr, \tag{11}$$

such that

$$E(Hrr'H) = HE(rr')H' = HH' = \hat{\Sigma}. \tag{12}$$

Since Σ is a symmetric positive definite matrix, Cholesky decomposition can be applied to obtain a unique lower triangular matrix H. From equations (8) and (12), it is clear that V in (11) is equal to that in (7).

Next, we explain how $\hat{V}$ is computed in this study. A trend equation for production is estimated using

$$S_i = \alpha_i T + U_i \quad (i = FSU, ROW) \tag{13}$$

where S is the wheat production in Country i, T is time trend (T = 1 in 1970 and 31 in 2000), α is the coefficient, and U is the stochastic disturbance. The estimated residual is

$$\hat{U}_i = S_i - \hat{\alpha}_i T. \tag{14}$$

The estimated variance of the residuals is denoted as $\hat{\sigma}^2$. The computed residual is

$$\hat{V} = r\hat{\sigma}. \tag{15}$$

Once $\hat{V}$ is computed, it is substituted into the trend production equation to generate the random production:

$$\hat{S} = \hat{\alpha} T + \hat{V}. \tag{16}$$

By repeating this process, twenty random production values are generated for FSU and ROW for the year 2000. Table 5 (Columns 2 and 3) presents the simulated values and coefficient of variations of production computed from the twenty simulated values. Of the twenty stochastic simulations, FSU production shortfalls (surpluses) occurred in nine (eleven) cases. Production values generated from each simulation are incorporated in the spatial equilibrium model, which is run twenty times to generate the values of other endogenous variables. Table 5 shows a scenario (Columns 4 and 5) where the FSU is assumed to normally be self-sufficient, but a substantial volume of trade is generated by instability due to random disturbances in supply. The coefficient of variation of 0.189 (Column 2) in production in the former Soviet Union exceeds that of the rest of the world, which is 0.071 (Column 3). Assuming the former Soviet Union became essentially self-sufficient in the long run, Column 4 shows that the region can still have an important role in world wheat trade, importing in certain years and exporting in other years.

Column 6 presents world price resulting from a scenario of stochastic supply only in the ROW and excluding FSU in the world wheat economy. It is interesting that while the stochastic role of the former Soviet Union in world wheat trade ranges from a net export high of 34.6 million metric tons to an extreme of 33.5 million metric tons in imports, the overall stochastic role of the former Soviet Republics contributes to slightly lower variability in world prices, as reflected in the coefficients of variation of world prices of 0.41 without Soviet stochastic trade, compared to 0.39 with Soviet stochastic participation. Both coefficients probably overstate stochastic influences on world trade and prices since the model exercise omits storage and livestock inventory adjustments that would buffer these variations somewhat. Johnson and Brooks (1983) and Desai (1986) have noted that much of the annual variability in Soviet production in the past could be attributed to policy and economic problems not associated with the climate. During the transition, shortages or delays of inputs could enhance the degree of variability, and on the other hand, successful transition to a more market-oriented agricultural sector could in time reduce the level of future variability.

Examination of extreme values of prices in the stochastic simulation run, however, explains the perception that the former Soviet republics, as a region, have contributed to volatility in world market prices. The range of prices varied from a low of $60.06 per ton to a high of $253.89 (runs 14 and 15, Column 5). Of course, the range is even greater without Soviet participation (runs 20 and 14, Column 6). A year in which domestic production in the former Soviet Union buffers large variations in production in the rest of the world, such as runs 6 and 3, may not stick in world memory as long as an event such as run 15, when a bumper crop in the rest of the world matches up with a bumper crop in the former Soviet Union.

Conclusions and Implications

The paper examined the impacts of a possible withdrawal of Russia and Eurasia from the world wheat market by the turn of the century. More and more trade analysts are predicting that the former Soviet Union will no longer be a significant net importer as price and market reforms suppress excess demand for wheat and/or hard currency financial pressures force an end to Soviet purchases of wheat imports.

The breakup of the former Soviet Union and the ongoing transition of the various former republics to market-oriented economies make it important, albeit difficult, to determine the future market role of the region in the global wheat economy. Through spatial trade modeling experiments, we have examined possible future scenarios in the world wheat economy that may occur if the former Soviet Union should evolve to a long-term self-sufficiency position by the turn of the century. The simulation runs demonstrate, as expected, that the evolution of the former Soviet Union to self-sufficiency in the world wheat market could have substantial effect on world trade/price levels and patterns. However, whether world prices will fall or increase in the next century depends on other economic policy parameters and trends as demonstrated in the OECD "global crisis" and "global shift" simulations. Even assuming self-sufficiency, because production in the region could on occasion throw the FSU into the world market as a large importer or exporter, the image of the area as a major source of volatility will probably continue, even though our simulations show that over time the region acts as a moderate buffer to production variations in the rest of the world.

At present, possible modeling exercises on scenarios in which the region becomes a net exporter are too varied to constrain, but if Nikonov is correct that the transition of the Soviet-type economies to market-oriented economies will be completed within a decade, it may be appropriate to look at these scenarios by the turn of the century.

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Appendix Table I.

Base Model Excess Demand and Supply Functions

Country/ Regions	Quantity (1000 T)	Elasticity	Price ($/ton)	Slope (1000 Ts)	Intercept (1000 Ts)
China	15423.3	-0.541	136.7	-61.0	23767.4
FSU	18084.3	-0.509	116.2	-79.2	27289.3
Japan	5592.9	-0.037	179.5	-1.2	5808.3
E. Asia	5198.9	-0.374	146.1	-11.1	5942.2
SE. Asia	2316.8	-0.259	156.9	-7.2	5496.1
Indonesia	1739.9	-0.255	149.4	-3.0	2183.6
Thailand	291.2	-0.259	176.2	-0.4	366.6
S. Asia	3990.1	-0.666	142.1	-18.7	6647.6
India	1124.8	-4.514	139.6	-36.4	6201.9
O. W. E.	779.4	-0.528	161.5	-2.6	1203.0
E. Europe	2910.7	-0.550	112.9	-14.3	4554.2
Mideast	11609.1	-0.500	122.0	-79.0	28915.3
Egypt	7104.8	-0.178	213.5	-5.9	8369.5
Brazil	1674.7	-0.084	132.9	-1.1	1815.4
Mexico	690.8	-1.071	132.6	-5.6	1429.3
C.Am.&Carib	2688.2	-0.109	146.2	-2.0	2981.2
O.S. Amer	2374.5	-0.300	145.8	-4.9	3086.8
Venezuela	1061.8	-0.350	149.9	-2.5	1433.4
Nigeria	63.8	-0.040	160.9	-0.02	66.3
N. Africa	7505.5	-0.365	141.1	-19.4	10245.1

(continued)

Appendix Table I (cont).

Base Model Excess Demand and Supply Functions

Country/ Regions	Quantity (1000 T)	Elasticity	Price ($/ton)	Slope (1000 Ts)	Intercept (1000 Ts)
WC. Africa	1470.7	-0.243	163.2	-2.2	1828.1
E. Africa	1720.6	-0.243	178.4	-2.3	2138.7
S. Africa	500.6	-0.243	149.2	-0.8	622.2
Columbia R.*	10388.8	0.449	154.4	30.2	5719.4
Puget S.*	419.1	2.100	154.4	5.7	-461.3
California*	765.0	1.285	154.4	6.4	-218.1
Gulf*	19930.0	0.701	149.1	93.7	5954.8
Atlantic*	1337.7	0.389	105.6	4.9	788.7
Great Lake*	1986.3	0.888	111.4	15.8	222.5
E. Canada*	7735.6	0.493	127.3	29.9	3916.6
W. Canada*	6117.8	0.579	131.4	26.9	2578.2
EEC-12	29610.7	0.165	160.7	30.4	24724.9
Australia	12581.1	0.137	122.6	14.1	10857.9
Argentina	4092.9	0.124	110.9	4.6	3585.4

Note: The slopes for the excess demand (supply) functions were calculated using a three year average (1987-1989) of prices and quantities. The elasticities were taken from USDA, *Embargoes, Surplus Disposal and U.S. Agriculture* (1986) unless otherwise designated.

* Excess supply functions for North American port regions were obtained by regressing export quantities on price.

Appendix Table II

Average Annual Growth Rate (%) Assumptions for World Wheat Economy Projections

	NAM	WEU	JAP	CE	DAEs	rASIA	ME	AFR	LAT	WLD
(a) Global Shift										
Population (OECD)	0.8	0.4	0.2	0.5	1.2	1.5	2.4	3.1	1.7	1.5
GDP (OECD)	3.4	1.9	4.3	0.4	7.3	6.5	3.6	2.9	4.3	3.4
Wheat Production										
World Bank	2.6	0.6	2.5	0.6	3.1	3.2	2.3	4.5	2.7	2.3
ERS	3.1	2.2	7.1	0.4	5.0	4.2	3.8	4.3	4.2	2.1
(b) Global Crisis										
Population (OECD)	0.8	0.3	0.2	0.5	1.2	1.5	2.5	3.1	1.7	1.5
GDP (OECD)	2.1	2.1	3.8	0.1	6.0	4.4	3.8	3.1	3.5	2.6
Wheat Production										
World Bank	2.6	0.6	2.5	0.6	3.1	3.2	2.3	4.5	2.7	2.3
ERS	3.1	2.2	7.1	0.4	5.0	4.2	3.8	4.3	4.2	2.1

Source: Organization for Economic Cooperation and Development (OECD), *Long-Term Prospects for the World Economy*, 1992 and the World Bank (WB) Price Prospects for Primary Commodities (Vol. II), 1992. Economic Research Service (ERS).

Note: NAM = North America (United States, Canada), Australia, and New Zealand; WEU = Western Europe (Yugoslavia, Israel, and Turkey); JAP = Japan; CE = Central Europe (Albania, Bulgaria, Czechoslovakia, Hungary, Poland, and Romania); DAEs = Dynamic Asian Economies (Hong Kong, Singapore, Taiwan, South Korea, Malaysia, Philippines, Indonesia, and Thailand); rASIA = Rest of Asia (also includes Melanesia, Micronesia, and Polynesia); ME = Middle East (Northern Africa, Bahrain, Cyprus, Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arabic Republic, United Arab Emirates, Yemen); AFR = Sub-Saharan Africa (Eastern, Middle, and Southern Africa); LAT = Latin America (South and Central America and the Caribbean); WLD = World; GDP = Gross Domestic Product.

Table 1. Base Period (1987-89) Solution Trade Flows (1000 tons) and Prices** ($/ton) with FSU Net Exports

Import Country Regions	Export Regions or Countries: Columbia River	Puget Sound	California	Gulf	Atlantic	Great Lakes	East Canada	West Canada	EEC	Australia	Argentina	Total	Import Prices
FSU				4184		2417	8192					14793	164.2
China	*	*	689					6430		6633		13752	157.8
Other Asia	9862	322		3280						6265		19729	159.8
Other Eur.									3089			3089	157.9
Mid. East/ North Afr.				3442	1482				26043			30967	158.7
Latin Amer				6730							1652	8382	150.1
Other Afr.				1173							2587	3760	167.0
Total	9862	322	689	18809	1482	2417	8192	6430	29132	12898	4239	94472	159.2
Export Prices	137.2	137.5	141.8	137.2	141.5	145.0	143.0	143.2	145.0	144.7	142.1	142.1	

* Reflects constraints on PNW shipments to China because of TCK quarantine.

** Trade weighted average price.

Table 2: Base Period (1987-89) Trade Flows (1000 tons) and Prices ($/ton) With FSU Self-Sufficient

Import Country Regions	Export Regions or Countries												Import Prices ($/ton)
	Columbia River	Puget Sound	California	Gulf	Atlantic	Great Lakes	East Canada	West Canada	EEC	Australia	Argentina	Total	
China	*	*	533	2026		1283		5775		5621		15238	139.8
Other Asia	9214	200		5472						6933		21819	136.4
Other Eur							870		2705			3575	129.0
Mid. East					1336	662	6423		25556			33977	129.8
Latin Amer				7157							1682	8839	121.5
Other Afr.				1487							2427	3914	138.5
Total	9214	200	533	16142	1336	1945	7293	5775	28261	12554	4109	87362	137.5
Export Prices	115.7	116.0	117.4	108.7	111.7	109.0	112.9	118.8	116.3	120.3	113.6	114.9	

*** Reflects constraints on PNW shipments to China because of TCK quarantine.**

**** Trade weighted average price.**

Table 3: Base, and Projected Scenarios of Wheat Imports and Prices With the FSU Self-Sufficient in 2000

	Base (1987-89)		2000 Global Crisis		2000 Global Shift	
Importing/ Countries Regions	Quantity (1000 T)	Price* ($/T)	Quantity (1000 T)	Price* ($/T)	Quantity (1000 T)	Price* ($/T)
			Importers			
FSU	14793	164.2	--	--	--	--
China	13752	157.8	23473	137.8	31909	188.9
Other Asia	19729	159.8	40514	134.4	49016	185.3
Other Europe	3089	157.9	980	126.5	884	175.9
Mid. East	30967	158.7	49538	127.9	44506	177.8
Latin Amer.	8382	150.1	13377	119.83	13581	171.0
Other Africa	3760	167.0	7734	137.0	7365	188.1
Import Price*		159.2		139.3		182.8
Total Imports	94472		135616		147261	

*Trade weighted average price

Table 4: Base, and Projected Scenarios of Wheat Exports and Prices With the FSU Self-Sufficient in 2000

	Base (1987-89)		2000 Global Crisis		2000 Global Shift	
Exporting/ Countries Regions	Quantity (1000 T)	Price ($/T)	Quantity (1000 T)	Price ($/T)	Quantity (1000 T)	Price ($/T)
			Exports			
Columbia R.	9862	137.2	14395	110.1	15935	161.2
Puget S.	322	137.5	2302	110.4	2584	161.5
California	689	141.8	3890	115.4	4126	166.5
Gulf	18809	137.2	24842	106.9	29422	157.9
Atlantic	1482	141.5	2111	110.1	2289	160.3
Great Lake	2417	145.0	4480	107.0	15134	158.1
E. Canada	8192	143.0	10165	111.3	11544	160.7
W. Canada	6430	143.2	8712	116.8	10051	167.9
EEC	29132	145.0	35691	114.3	36683	164.3
Australia	12898	144.7	13761	118.3	14410	169.4
Argentina	4239	142.1	5269	113.2	5082	164.3
Export Price*		142.1		111.9		162.5
Total Exports	94472		135617		147260	

*Trade weighted average price

Table 5: Random Supply Shocks and the Impact of a Self-Sufficient FSU on Wheat Trade and Prices

(1) Run	(2) FSU Stochastic Production (1000 T)	(3) ROW Stochastic Production (1000 T)	(4) Self-Suff. FSU Stochastic Net Trade (1000 T)	(5) Trade Weighted World Price FSU Stochastic Trade ($/ton fob)	(6) Trade Weighted World Price without FSU Stochastic Trade ($/ton fob)
1	94572	519159	4106	187.03	196.07
2	71139	577623	-14088	210.66	180.58
3	79116	629193	-12920	101.96	77.19
4	102942	575306	8229	68.37	84.75
5	86663	539728	-3696	162.86	90.30
6	123397	479045	34580	180.50	248.16
7	119531	579640	19162	64.67	101.16
8	65672	554768	-18549	208.56	171.47
9	92522	538645	2064	229.47	234.82
10	61825	608232	-33477	198.76	126.64
11	97935	533585	5574	148.46	186.81
12	81376	541158	-6992	222.99	209.72
13	122465	532690	31479	159.66	224.03
14	94235	487077	4518	253.89	264.50

(continued)

Table 5: Random Supply Shocks and the Impact of a Self-Sufficient FSU on Wheat Trade and Prices (cont.)

(1) Run	(2) FSU Stochastic Production (1000 T)	(3) ROW Stochastic Production (1000 T)	(4) Self-Suff. FSU Stochastic Net Trade (1000 T)	(5) Trade Weighted World Price FSU Stochastic Trade ($/ton fob)	(6) Trade Weighted World Price without FSU Stochastic Trade ($/ton fob)
15	107582	585776	11279	60.06	82.21
16	102629	532603	12271	171.99	198.83
17	87544	542962	-2256	223.23	218.38
18	106527	595896	11599	84.06	108.10
19	81263	584481	-9752	131.63	110.92
20	86485	606842	-5211	79.36	65.57
Mean	93271	557220		157.41	159.01
Coefficient of Variation	0.189	0.071		0.39	0.41

Note: Negative sign reflects net wheat imports. FSU = Former Soviet Union, ROW = Rest of World. fob = price at export origins. Positive (negative) net trade in exports (imports).