Longer-Term Forecasting of Commodity Flows on the Mississippi River: Application to Grains and World Trade

Appendix

by
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Project titled *Longer-Term Forecasting of Commodity Flows on the Mississippi River: Application to Grains and World Trade* Prime Contract # W912HQ-04-D-0007, DO#15. This appendix provides all the background data, manipulations and description of the methodology. provides the summary for this study and the major results. An accompanying report titled *Longer-Term Forecasting of Commodity Flows on the Mississippi River: Application to Grains and World Trade* provides a summary of the problem, the results and implications.

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1. Review of Studies

A number of studies have conducted longer-term forecasts on flows on the Mississippi River system e.g. FAPRI, Sparks, USDA, etc. These models are for policy purposes and generally use econometric based models for projections. Most important is that they do not address issues related to spatial competition, transportation and intermodal competition. As a result, they are generally limited in terms of providing estimates for infrastructure planning. Other studies (Baumel, 2001 and Baumel and Van Der Kamp, etc.) caution about the use of these types of models for infrastructure planning.

Some studies have forecast trade flows, either internal or seaborne, utilizing past relationships for flows. Studies that have focused on Mississippi river traffic include Babcock and Xiahhau; Jack Faucett Associates 1997, 2000; and Tang. Others include Veenstra and Haralambides who focused on major seaborne trade flows. Babcock and Xiannau address short term forecasting of inland waterway grain traffic. Faucett and Associates forecast barge traffic on the Upper Mississippi and Illinois River system where shares of barge traffic (inland) were allocated based on fixed shares of exports. Veenstra and Haralambides developed multivariate autoregressive time series models to forecast seaborne trade flows for crude oil, iron ore, grain and coal using data from 1962-1995 to develop forecasts for 1978-2005. They indicate results for the models produced long-term seaborne trade flow estimates that had relatively small forecast errors.

Several studies have focused specifically on transport infrastructure and trade flows. Fellin and Fuller (1997) developed a model to examine effects of waterway use tax on U.S. grain flows for corn and soybean sectors. A quadratic programming model of corn and soybean sectors was developed that maximizes net social payoffs or consumer plus producer surplus minus grain handling, storage and transportation costs. The model examined the effects of a proposal to increase barge fuel taxes from $0.20/gallon to $1.20/gallon on agricultural exports of corn and soybeans. Barge costs were estimated utilizing a barge costing model from Reebie Associates. Barge costs were estimated by simulating movement of a barge over the complete cycle where transit times were estimated based on length of haul, number of locks encountered and prospective delay times at given locks. They found increases in barge fuel taxes would divert 10.6 mmt from inland waterways, of which 70% of diversions would be from the upper Mississippi/Illinois river system. Producers in Minnesota, Illinois and Iowa would incur 75% of expected decline in producer revenues (151 Million). Total exports of soybeans are nearly unchanged, while corn exports declined 2.2%.

Fuller et al. (1999) developed a spatial equilibrium model to examine the effect of grain transportation capacity on the upper Mississippi and Illinois rivers on trade flows. The model maximizes net social payoff of consumer plus producer surplus minus costs for grain handling, storage and transportation. The model utilized a regression equation to determine average lock delay time for shipping where:

$$\text{Average delay} = f(\text{Portion of lock capacity utilized})$$

Barge transportation costs for selected loading sites on the two rivers were estimated for different capacities with the tow delay equation, annual lock capacity information and a barge costing model. They indicate 58% of traffic would be diverted due to increased congestion. This model is only relevant for short term forecasts as they do not include elasticities between transport modes which may have significant effects over longer terms.

Fuller et al. (2000) used a similar model to evaluate effects of updating the Panama canal and subsequent increase in toll charges on trade flows focusing on barge flows along the Mississippi. They found change in toll from $1.50/MT to $3.50/MT introduced significant changes in trade flows represented by shifts in corn and soybean exports from gulf ports to Northern Pacific ports and shift from gulf soybean shipments to Asia via the canal to shipments around Africa's Cape of Good Hope to Asia.

Supply and Demand Elasticities for Transportation Modes.

There are studies that have examined supply and demand elasticities for modes of transportation. Oum et al. reviewed recent estimates of price elasticities for different modes of transportation. Reviews over 70 studies that report elasticities of demand for several modes of transit and market situations. They indicate that since transportation is a derived demand, it tends to be inelastic. They list range of elasticities from studies for rail freight for corn, wheat of 0.52-1.18 (3 studies), truck for corn, wheat of .73-.99 (2 studies), inland waterways for grain of .64-1.62 (2 studies), and ocean shipping for dry bulk shipments of .06-.25 (1 study).

Dager, et al. 2004, reviewed the assumptions on USACE models for Ohio and Upper Mississippi/Illinois river systems. The UMR-IWW group relate maximum willingness to pay as: 1) shift in mode, 2) geographical shift in destination, 3) geographical shift in origin, and 4) a no long-haul transportation alternative. The paper provides evidence to indicate that axioms 2-4 are less likely to occur than axiom 1 and therefore the minimum of alternatives is most likely modal shift.

Dager, et al. 2004 also reviews study by Yu and Fuller that econometrically estimated elasticity of grain barge shipments on the UMR-IWW. Yu and Fuller found elasticities were inelastic for (-.2 for Illinois river, -.6 for reach 3 (Mpls to IA)). Dager al., estimated elasticities for barge shipment as -.7, -.3, -.42 and -.57 for lower Mississippi, middle Mississippi, Illinois and Upper Mississippi river waterways.

Dager et al., indicate that inelastic nature of grain barge shipments along UMR-IWW may be due to shifts that have occurred in rail equipment (larger cars and locomotives) that have resulted in less movement options, rise in direct shipment from growers to barge loading facilities rather than shipment to local elevator and truck/rail shipment to barge facilities. These shifts have resulted in more production areas along rivers being left with less alternatives to changes in barge rates. This they argue, reduces potential for axioms 2-4 occurring and argues that only axiom of concern is shift in mode. However, this study focuses only on barge elasticities of demand.

Two studies analyzed short term supply and demand for rail and barge shipments to the US Gulf and PNW. One analyzed pricing by railroads and estimated a system of structural equations to analyze the dynamic nature of arbitrage (Miljkovic, 2001). Monthly data was used and results indicatd the railroad industry is noncompetitive and rates converge at a different speed in different regions. Elasticities were not reported but the inverse relationship between rail rates and demand were significant in two cases. There was also an important relationship between the Gulf-PNW corn price spread and rates from different origins. Export levels were also significant and important and were inversely related to rail rates. Monthly dummy variables were important as well. In Miljkovic et al, the competition between barge and rail were analyzed using monthly data. Supply and demand equations were estimated. Price variables in the demand and supply equations had mixed results with some being significant and others not, and the Gulf-PNW price spread variable was significant.

Sweeney (2003) examined issues related to elasticity of demand for transportation services. He provides a comparison of the results of traditional ACE economic model estimate of benefits for UMM-IRW ($128 million) and contrasts them to one utilizing elasticity of demand for freight ($25 million). The difference is largely due to inaccurate forecast of future use without the project. Flatter real demand curves for water transportation (the more own-price elastic), the greater the divergence between benefits between traditional ACE predictions and elasticity of demand predictions.

Three prior surveys of journal articles examined elasticities for transportation (Waters, 1984, 1989 and Oum 1990). Conclusions on surveys and recent studies on transportation elasticities indicate 1) Barge own-price elasticities appear greater in absolute value than rail own-price elasticities which are larger than truck own-price elasticities. 2) Absolute long run rail own price elasticities are slightly greater than 1 and truck are slightly less or near one; Freight elasticities increase as the share of transportation costs in total production costs increase. 3) Rail and barge elasticities increase with distance of haul while truck elasticities decrease with distance of haul. 4) Limited results for cross-price elasticities, those that exist are relatively low in absolute value, and 5) Freight own-price elasticities appear to be greater absolute value in markets that have some degree of modal competition and in the case of water transportation. Own price elasticities of demand appear to be larger in absolute value at greater distances removed from river access.

2. Consumption Functions and Import Demand

2.1 World Historical Consumption: Wheat, Corn and Soybeans

World consumption on wheat, corn, and soybeans has grown substantially since 1960 Figures 2.1.1-2.1.3). Wheat consumption leveled off during the 1990's, while corn consumption is growing at a steady rate. Soybean consumption is increasing at an increasing rate.

Figures 2.1.4 -2.1.6 show the percentage change in wheat, corn and soybean consumption in the major countries/regions of the world. Wheat consumption in South East Asia (SEA) has grown by 157% since 1980 followed by South Africa (99.7%), South Asia (92.8%), and North Africa (80.6%). The world consumption of wheat has grown by 33.5% since 1980. The world consumption of corn has grown by 60% since 1980, Figure 2.1.5. The largest growth is in South Korea (268%) followed by North Africa (191%) and Australia (180%). World soybean consumption has grown by 188% since 1980. The largest growth is in South Asia (1440%) followed by Latin America (1096%) and North Africa (766%).

The largest consumer of wheat for importing countries is China, at around 100 to 110 million metric tons, Figure 2.1.7. The next largest consumer is North Africa (30 million metric tons) followed by SEA (18 million metric tons). South East Asia is the largest corn consuming region among importers at about 30 million metric tons Figure 2.1.8. Mexico (26 million metric tons) is followed by Latin America (18 million metric tons) and Japan (16 million metric tons). China is the largest consuming importing country for soybeans (37 million metric tons) Figure 2.1.9). China is followed by the European Union (19 million metric tons) and SEA (8 million metric tons). China’s consumption has increased 330% since 1991.

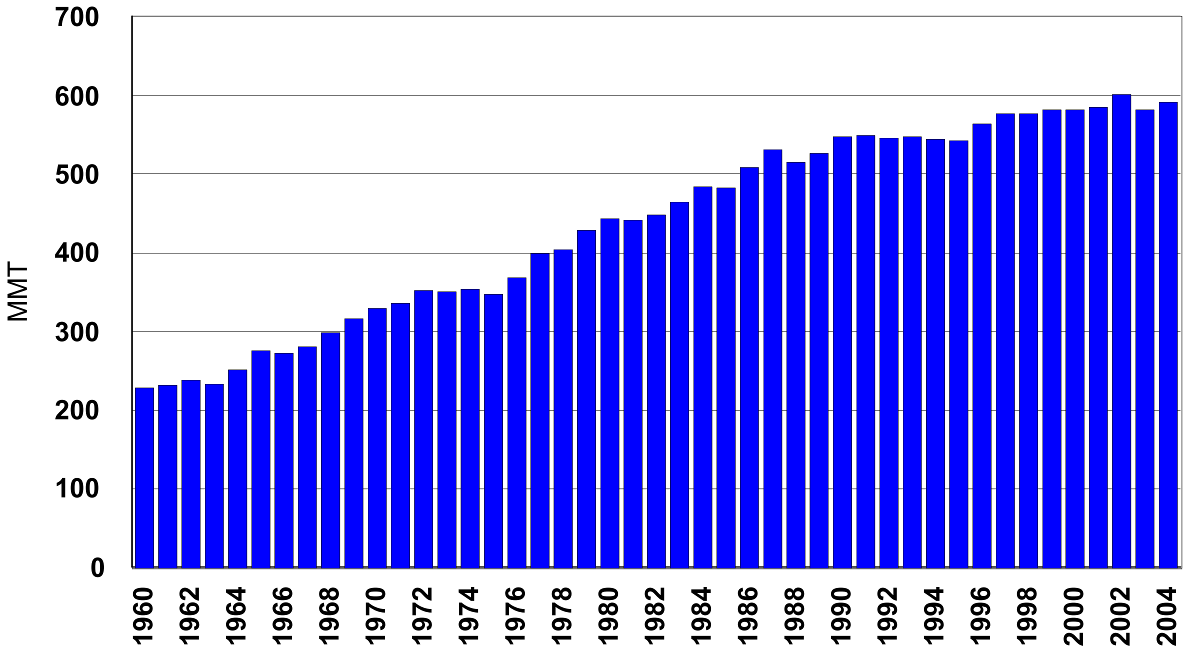


Figure 2.1.1 World Wheat Consumption, 1960-2004.

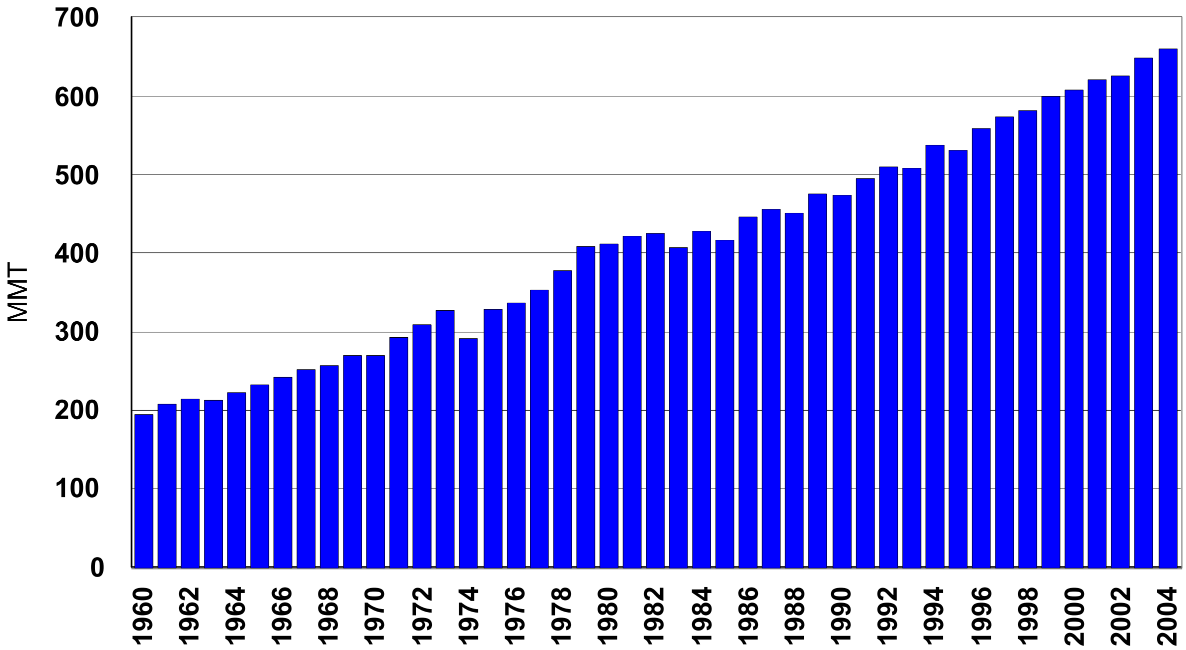


Figure 2.1.2 World Corn Consumption, 1960-2004.

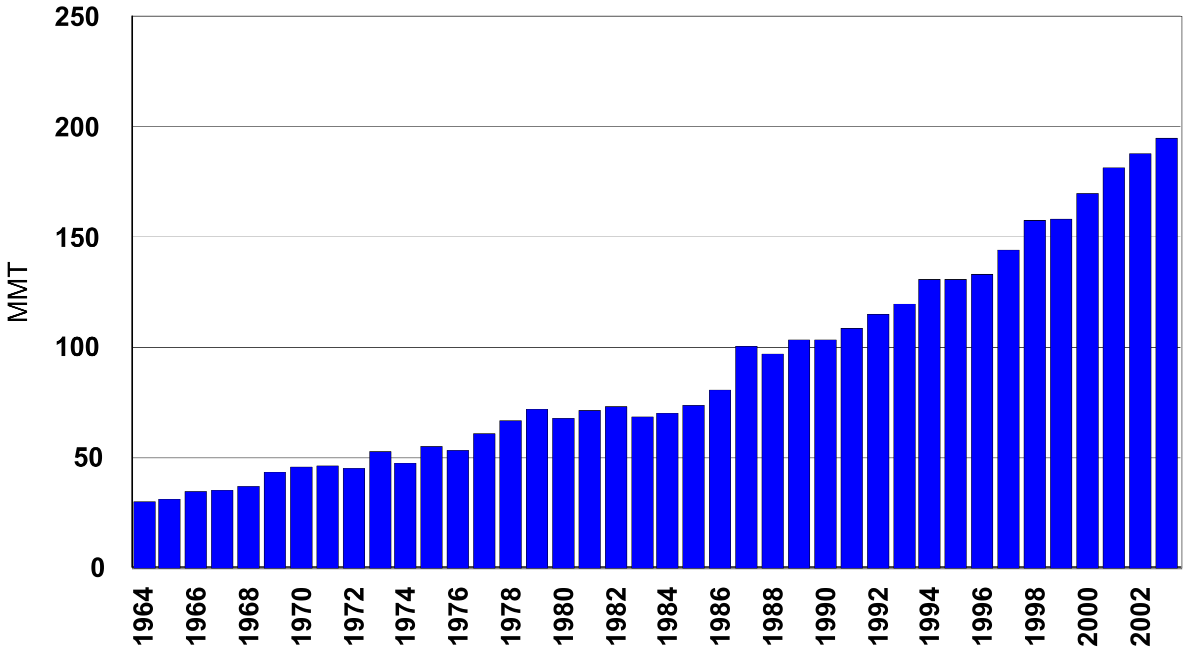


Figure 2.1.3 World Soybean Consumption, 1964-2003.

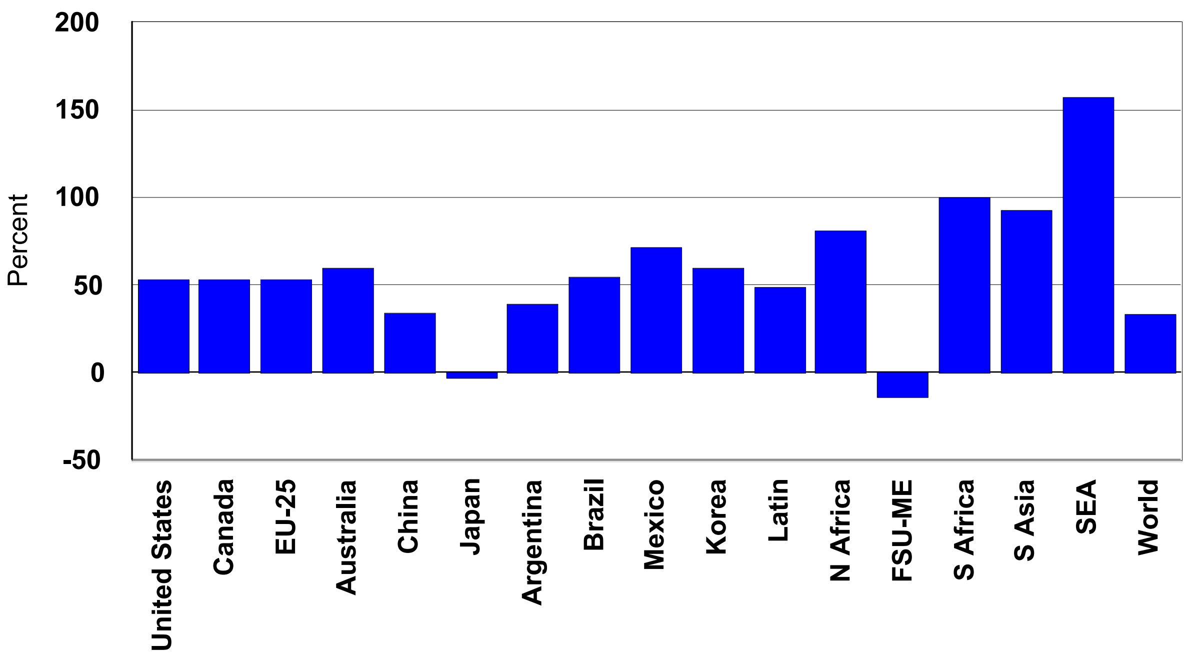


Figure 2.1.4 Change in World Wheat Consumption, 1980-2004.

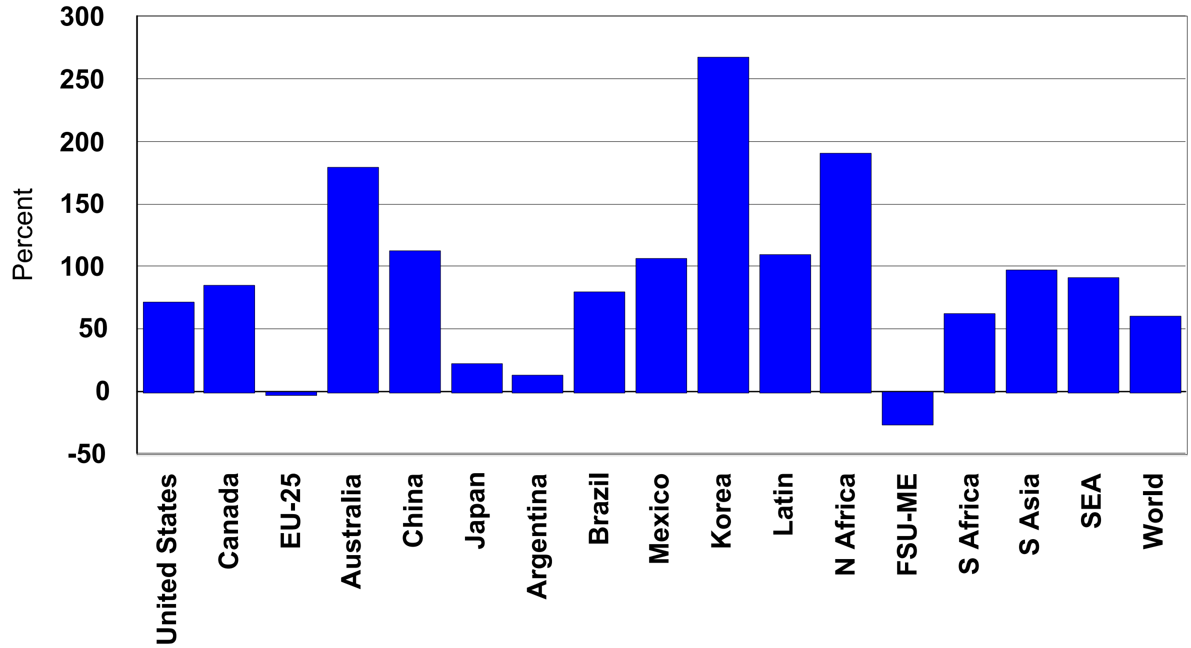


Figure 2.1.5 Change in World Corn Consumption, 1980-2004.

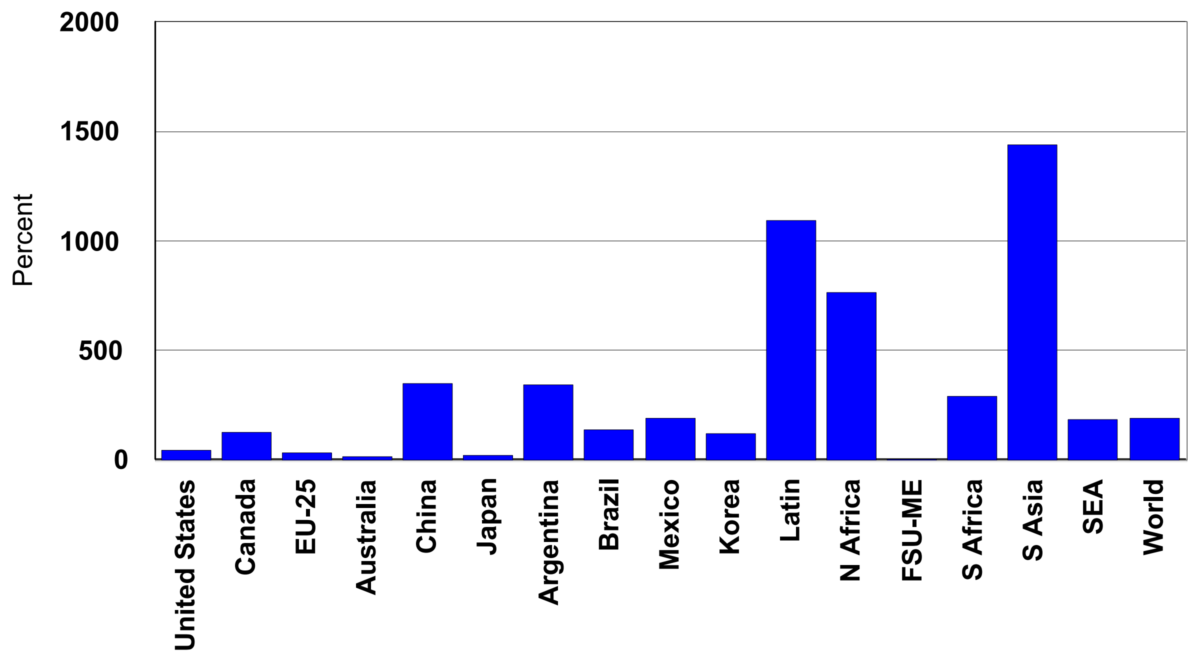


Figure 2.1.6 Change in World Soybean Consumption, 1980-2003.

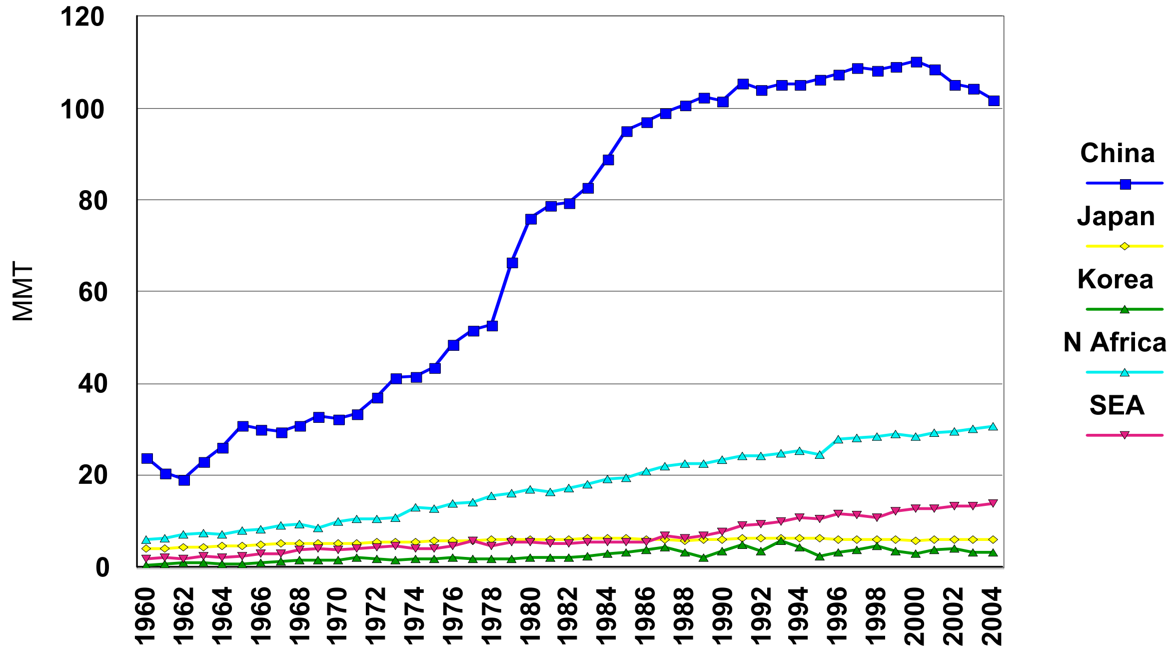


Figure 2.1.7 Wheat Consumption for Selected Importers, 1960-2004.

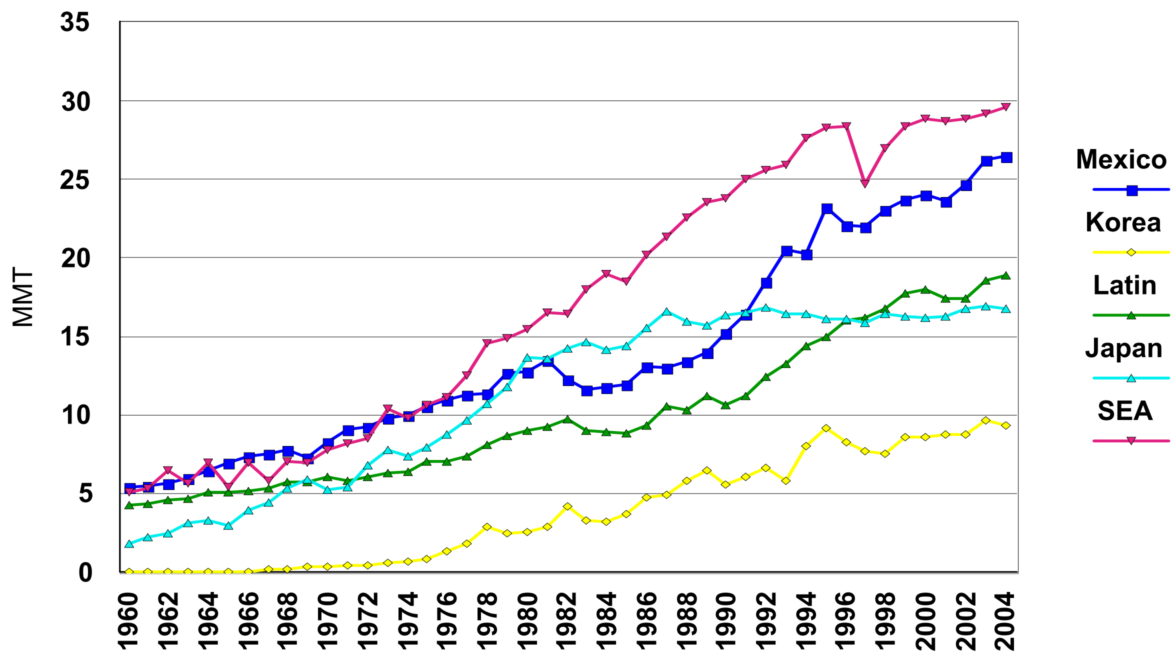


Figure 2.1.8 Corn Consumption for Selected Importers, 1960-2004.

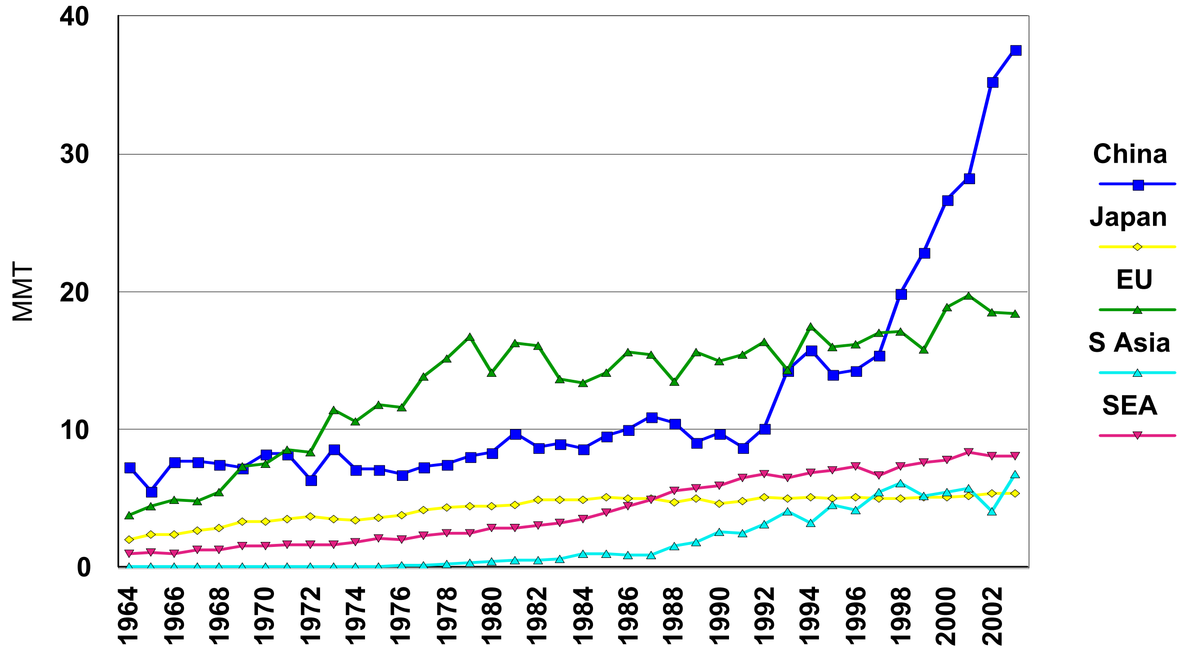


Figure 2.1.9 Soybean Consumption for Selected Importers, 1964-2003.

2.2 Estimation of Consumption Functions.

Consumption functions were estimated for the 3 crops in 16 countries and 11 multi-country regions. Data were taken from USDA-ERS PS&D for consumption and income was obtained from Global Insights.

A double log functional form could be used because of the nonlinear relationship between income and consumption. However that method assumes that the income elasticity remains constant over time. With a forecast period of 45 years, per capita income increases substantially, especially in developing countries. With the increasing per capita incomes, income elasticities should decrease.

To capture this, the income elasticities for 54 countries were estimated for the three crops using a two-step procedure. First, a consumption function was estimated for each country: $C=f(Y)$ for each crop where C is per capita consumption and Y is income. A double logarithmic equation was estimated. These results generated an income elasticity for each country and crop, E_{ci}. The second step was to estimate the relationship between the elasticity and the per capita income. The notion here is that as incomes increase, there would be a tendency for the income elasticity to decline. Thus, as a countries' income changes, there is a shift in consumption to be similar to other countries at similar stages in development. An equation was estimated to determine the rate of change in income elasticities as per capita income increases.

$$E_{ci} = C_{ci} - A_{ci}(Y_{ci})^{.5}$$

where

c=country and i=crop. That estimated elasticity was used to generate the consumption response to changes in per capita income.

Table 2.2.1 show the estimated income elasticities for the countries/regions used in the study for the three crops. The three equations are shown in Table 2.2.2. The R^2 are between 0.85 and 0.86 and both the constant term and coefficients are similar. Income elasticities for developed countries, United States, Japan, and Australia are much lower than developing countries like Mexico, China, and Brazil. Figures 2.2.1 -2.2.3 show the plot of estimated income elasticity compared to per capita income. The data points move from high per capita income and low elasticity to low per capita income and high elasticity.

Table 2.2.1. Income Elasticities for Exporting and Importing Regions/Countries

	Wheat	Corn	Soybean
S Asia	0.51	0.78	0.53
FSU-ME	0.39	0.64	0.41
SEA	0.24	0.48	0.27
Europe	0.16	0.34	0.19
Latin	0.41	0.67	0.44
S Africa	0.60	0.83	0.61
N Africa	0.41	0.66	0.44
Argentina	0.25	0.55	0.29
Australia	0.14	0.32	0.17
Brazil	0.40	0.66	0.43
Canada	0.16	0.30	0.17
Korea	0.19	0.48	0.23
Mexico	0.36	0.63	0.39
United States	0.05	0.11	0.06
Japan	0.16	0.31	0.18
China	0.44	0.73	0.47

Table 2.2.2. Regression Results for the Income Elasticity Equations

	Constant	Coefficient	R^2
Wheat	0.551	-0.078	0.846
	(9.525)	(-23.183)	
Corn	0.836	-0.096	0.862
	(12.438)	(-24.735)	
Soybean	0.574	-0.077	0.856
	(10.424)	(-24.130)	

*t ratios are in ( ).

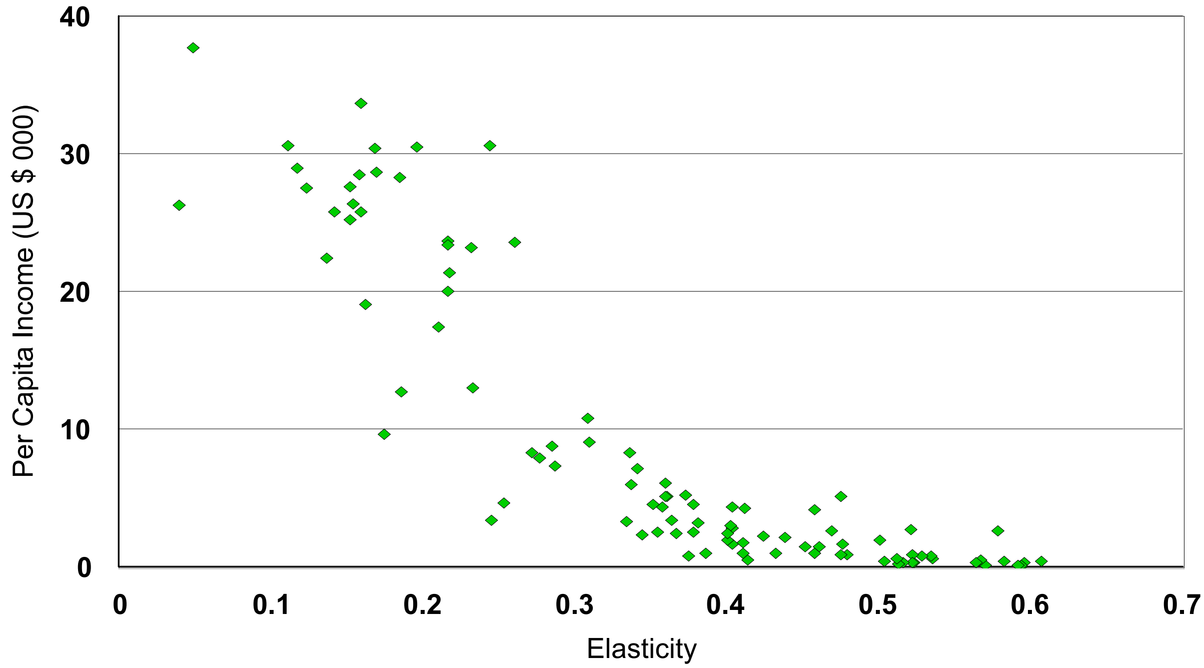


Figure 2.2.1 Income Elasticity for Wheat.

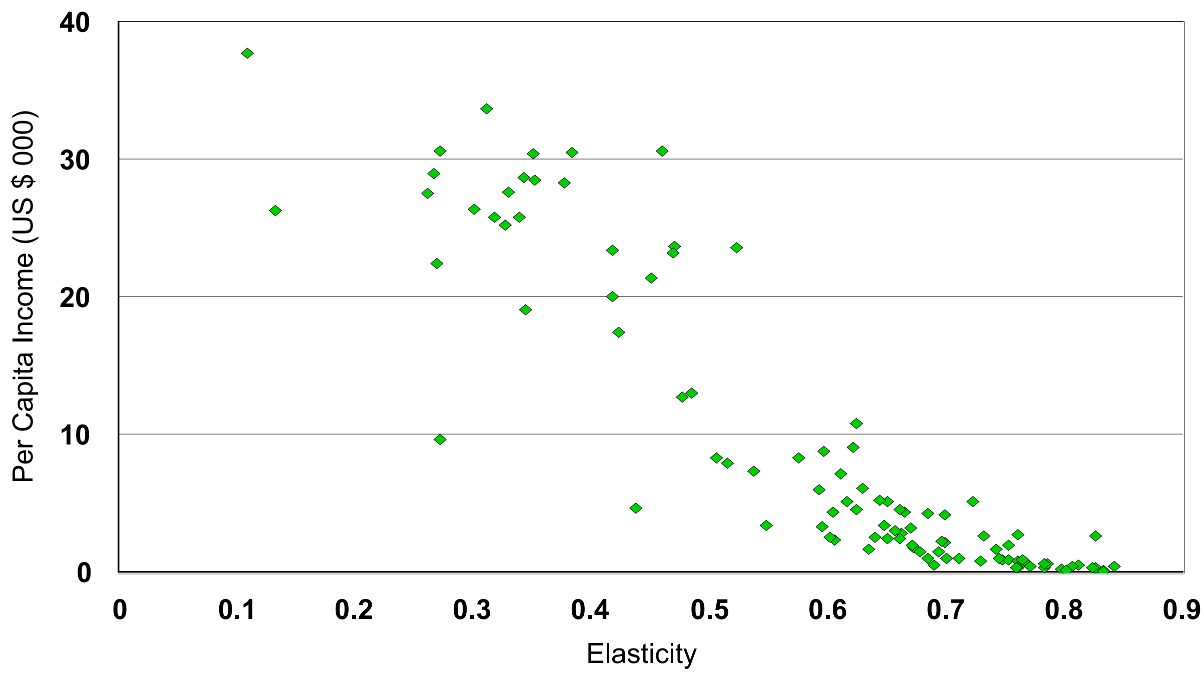


Figure 2.2.2. Income Elasticity for Corn.

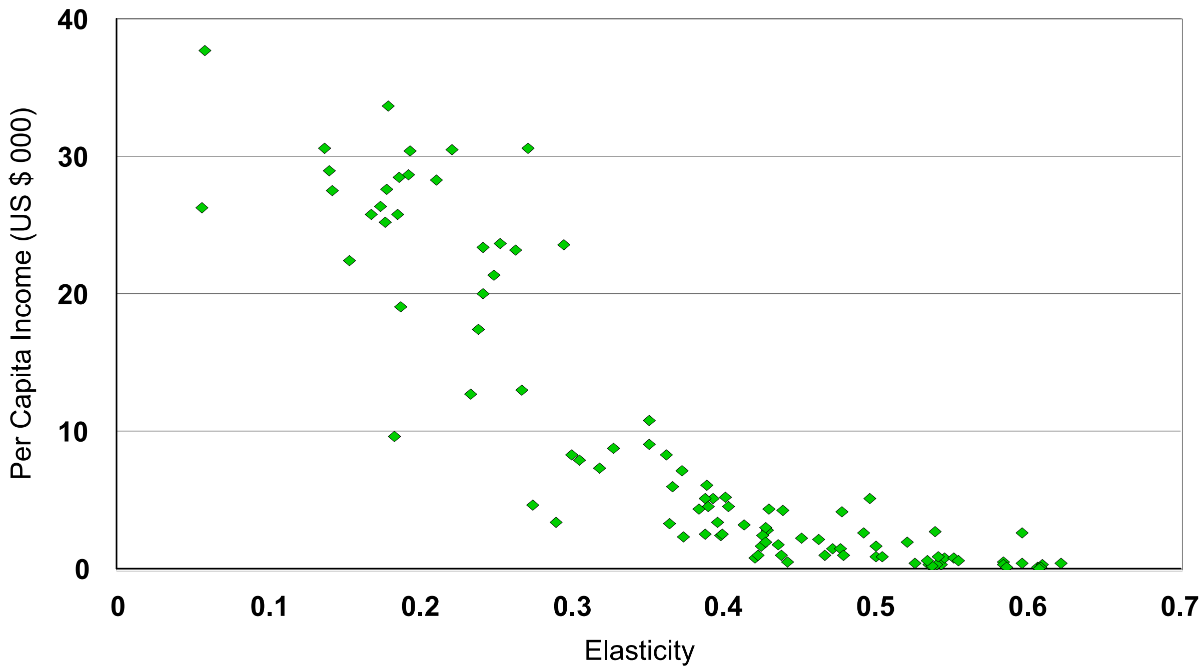


Figure 2.2.3. Income Elasticity for Soybeans.

Table 2.2.3. Estimated Income Elasticities For Selected Regions/countries

	Wheat				Corn				Soybeans			
	2003	2010	2015	2025	2003	2010	2015	2025	2003	2010	2015	2025
U. S.	0.05	0.01	-0.02	-0.08	0.11	0.06	0.02	-0.05	0.06	0.02	-0.01	-0.07
Canada	0.16	0.12	0.10	0.07	0.30	0.26	0.24	0.20	0.17	0.14	0.12	0.09
EU	0.16	0.13	0.11	0.07	0.34	0.31	0.29	0.23	0.19	0.16	0.14	0.10
Australia	0.14	0.12	0.10	0.05	0.32	0.28	0.26	0.21	0.17	0.14	0.12	0.08
China	0.44	0.42	0.41	0.37	0.73	0.71	0.69	0.64	0.47	0.45	0.44	0.40
Japan	0.16	0.12	0.10	0.04	0.31	0.26	0.23	0.16	0.18	0.14	0.11	0.06
Argentina	0.25	0.23	0.21	0.18	0.55	0.53	0.51	0.47	0.29	0.27	0.26	0.22
Brazil	0.40	0.39	0.38	0.35	0.66	0.65	0.63	0.60	0.43	0.42	0.40	0.38
Mexico	0.36	0.34	0.33	0.29	0.63	0.61	0.59	0.54	0.39	0.37	0.36	0.32
S. Korea	0.19	0.14	0.10	0.05	0.48	0.41	0.38	0.31	0.23	0.18	0.15	0.10
Latin	0.41	0.39	0.37	0.33	0.67	0.65	0.63	0.58	0.43	0.42	0.40	0.36
N Africa	0.41	0.40	0.39	0.37	0.66	0.64	0.63	0.60	0.44	0.42	0.41	0.39
FSU-ME	0.39	0.37	0.36	0.34	0.64	0.61	0.60	0.57	0.41	0.40	0.38	0.36
S Africa	0.60	0.59	0.59	0.58	0.83	0.82	0.82	0.81	0.61	0.60	0.60	0.59
S Asia	0.51	0.50	0.49	0.48	0.79	0.78	0.77	0.75	0.53	0.52	0.52	0.50
SEA	0.24	0.23	0.22	0.19	0.48	0.46	0.45	0.42	0.27	0.26	0.25	0.22

Table 2.2.3 shows the estimated income elasticities for the countries/regions in the study for the selected years between 2003 and 2025. Income elasticities fall from 2003 to 2025. For example, for China soybeans the elasticity falls from 0.47 to 0.40. Regions which are not projected to have substantial income growth, like South Africa the elasticities fall very little.

Using these estimated income elasticities, per capita consumption was calculated. The equation was specified by:

$$PCC_{cit} = (PCC_{cit-1} + (\text{Percent change in } PCI_{cit})(E_{cit})$$

where c= country, 1 to 16, i= crop, 1 to 3, and t=year, 2004 to 2025. From these results, we derived the total domestic demand for each grain in each country or region. These are summarized in Table 2.2.4 and in Figure 2.2.4 for selected countries and regions.

Import demand (MD) for each crop in the countries/regions were defined as $MD_{cit} = DD_{cit} - DP_{cit}$ where total production (DP) and domestic consumption (DD). If MD is positive, country c is an importing country, while country c is an exporting country if MD is negative.

Table 2.2.4. Estimated Percent Change (to 2025) in World Consumption

	Wheat	Corn	Soybean
		Percent Change	
United States	0.19	0.22	0.20
Canada	0.20	0.27	0.21
Europe	0.08	0.16	0.09
Australia	0.19	0.28	0.20
China	0.82	1.54	0.89
Japan	0.00	0.06	0.01
Argentina	0.35	0.58	0.38
Brazil	0.56	0.82	0.58
Mexico	0.53	0.81	0.56
South Korea	0.17	0.46	0.22
Latin	0.67	0.95	0.70
N Africa	0.82	1.17	0.85
FSU-ME	0.52	0.78	0.54
S Africa	0.87	1.06	0.88
S Asia	1.00	1.52	1.04
SEA	0.47	0.73	0.50
World	0.55	0.71	0.46

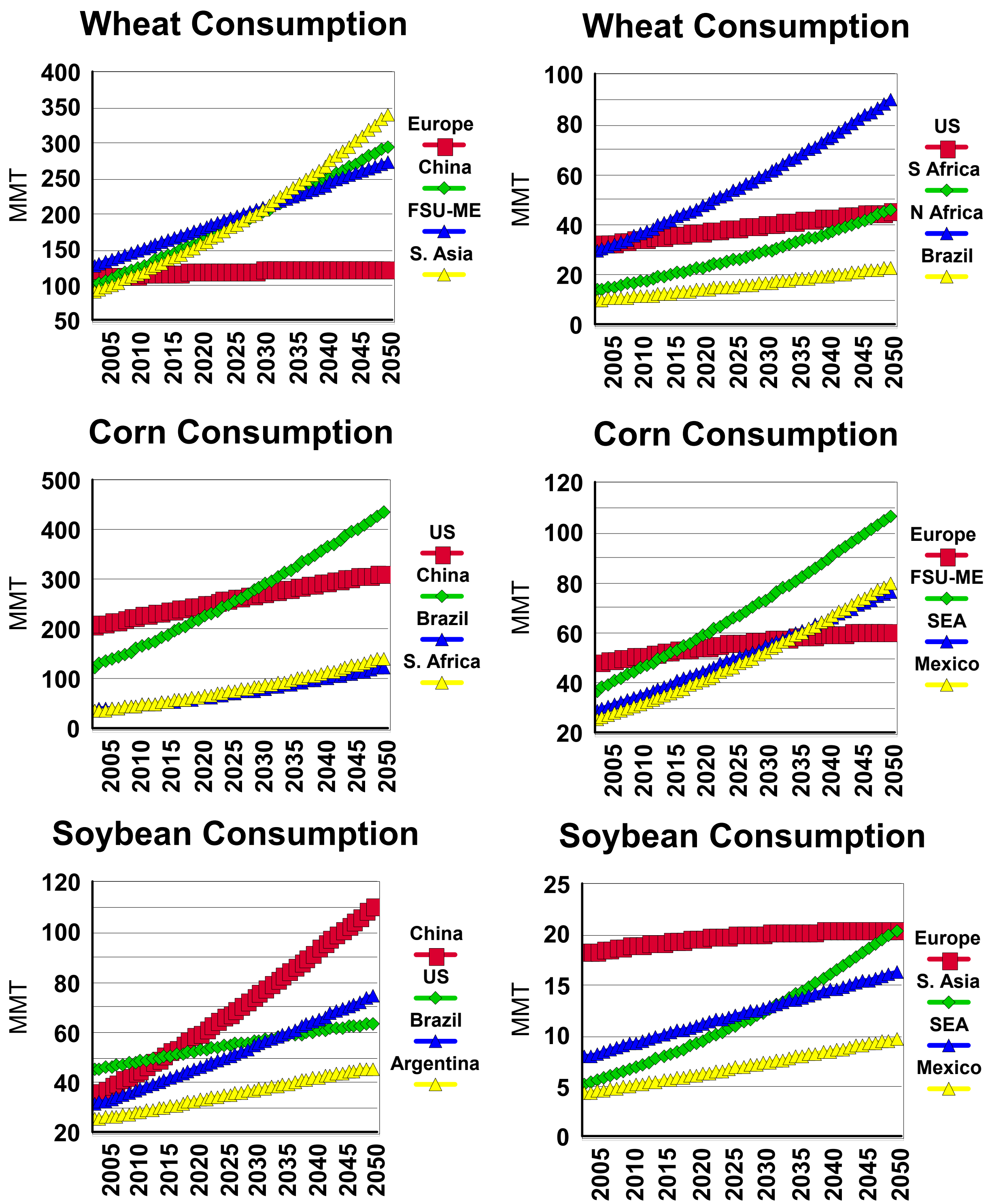


Figure 2.2.4 Forecast Consumption for Selected Importing Countries/Regions 2005-2050.

3. World Production: Area and Yield Projections

3.1 World Historical Production: Wheat, Corn, and Soybeans Table 3.1 shows the historical yields for wheat in major producing countries. Europe has the highest yield followed by the United States. Wheat yields in Australia and Argentina have increased the greatest since 1980, 69% and 63% respectively. Yields in the Canada and the United States have increased the least, 13% and 19% respectively. The percentage change in all these tables are calculated from 1980-81 to 2001-02 years.

Table 3.2 show the corn yields for major corn producing countries. The yield for the United States is substantially higher than either China or Mexico, but yields for both are increasing at a faster rate.

Soybean yields are similar in the major producing countries/regions. However, yields in the United States are slightly higher than areas in South America.

Table 3.1. Wheat Yields for Major Exporting Countries/Regions

	United States	Canada	Argentina	Europe	FSU ME	Australia
			MT/HA			
1980	2.25	1.74	1.55	3.80	1.44	0.96
1985	2.52	1.77	1.61	4.28	1.42	1.38
1990	2.66	2.28	1.91	4.81	1.99	1.63
1995	2.41	2.25	1.91	4.68	1.47	1.79
2000	2.83	2.44	2.58	4.98	1.56	1.83
2002	2.75	2.28	2.50	4.95	1.74	2.03
% Change: 1980-2001	19	13	63	32	33	69

Table 3.2 Corn Yields for Major Producing Countries

	United States	Mexico	China
		MT/Acre	
1980	5.71	1.28	3.08
1985	7.41	1.69	3.61
1990	7.44	2.14	4.52
1995	7.12	2.28	4.92
2000	8.59	2.36	4.60
2002	8.64	2.65	5.30
% Change: 1980-2001	38	80	63

Table 3.3. Soybean Yields for Major Exporting Countries/Regions

	United States	Argentina	Brazil	Latin
		MT/HA		
1980	1.78	2.01	1.79	1.54
1985	2.29	2.20	1.49	1.34
1990	2.29	2.42	1.62	1.63
1995	2.38	2.08	2.20	2.12
2000	2.56	2.65	2.79	2.47
2002	2.72	2.51	2.52	2.43
% Change: 1980-2001	42	24	57	56

Many of the major exporting countries/regions have decreased the harvested areas of wheat since 1980 (Table 3.4). United States and Canada have decreased wheat area about 33% and 7% respectively during the time period. FSU-ME area has fallen about 20% during the same time period but that was during the breakup to the Soviet Union which may be the cause of the reduced area. Argentina has increased wheat area by 20% followed by Australia at 10%. Total harvested wheat area has increased 2.9% since 1980.

World harvested area for corn has fallen 8.9% since 1980. Harvested area for the United States has fallen 5.9% while corn area in China has increased 17% during the time period. Harvested area in Brazil has increased 66% from 8.5 million hectares to 15.9 million hectares since 1980.

The world soybean area increased 53.7% since 1980. In 1980, 49 million hectares were planted to soybeans. By 2003, 78 million hectares were harvested. The main increases were in South America. Mainly Argentina, Brazil, and Uruguay. Harvest area increased 477% from 1.7 million hectares in 1980 to 11.1 hectares in 2002. Brazil increased harvested area from 8.5 million hectares in 1980 to 15.9 million hectares in 2002. United States increased harvested area 8.5% during the time period.

Table 3.4. Wheat Harvest Area for Major Exporting Countries/Region, Thousand Hectare

	United States	Canada	Argentina	Europe	FSU ME	Australia
			HA (000)			
1980	28,773	11,098	5,023	25,997	79,345	11,283
1985	26,185	13,729	5,270	26,195	68,606	11,736
1990	27,965	14,098	5,700	27,085	66,752	9,218
1995	24,668	11,141	4,500	25,859	65,008	9,221
2000	21,502	10,962	6,392	26,817	61,306	13,002
2002	19,689	11,000	6,800	26,517	64,357	12,500
% Change: 1980-2001	-32.9	-6.6	20.4	4.0	-19.5	10.1

Table 3.5. Corn Harvest Area for Major Producing Countries

	United States	Mexico	China
		HA (000)	
1980	29,526	8,100	20,353
1985	30,436	6,200	17,694
1990	27,095	6,600	21,402
1995	26,390	7,800	22,767
2000	29,316	7,510	23,056
2002	27,846	7,870	23,500
%Change: 1980-2001	-5.3	-4.2	17.0

Table 3.6. Soybean Harvest Area for Major Exporting Countries/Regions

	United States	Argentina	Brazil	Latin
		HA (000)		
1980	27,443	1,740	8,501	492
1985	24,929	3,316	9,450	727
1990	22,870	4,750	9,750	1,257
1995	24,906	5,980	10,950	1,680
2000	29,303	10,380	13,970	1,959
2002	29,542	11,100	15,900	2,057
% Change: 1980-2001	8.5	476.5	78.8	289.1

3.2 Estimated Crop Yields and Production Potential Production and production potential were derived for each country and region as follows. Yield functions were estimated as a function of trend where:

$$Y = f(\text{trend})$$

where Y is the yield for each of the crops. These were estimated as a logarithmic function to allow for nonlinear relationship. These were derived for each country and crop.

Forecasted yields for each of the countries are shown in Table 3.7-3.9 for each of the major producing countries. Results show that yields in Argentina and Australia are growing relative to those in North America and Europe and by 2025 will converge toward values in those countries.

Using the product of these two variables, we derived the production potential for each country and region. Percentage changes are shown in Table 3.10 and the projections for major producing regions are shown in Figure 3.3.1.

Table 3.7. Estimated Wheat Yields for Major Exporting Countries/regions

	United States	Canada	Argentina	Europe	FSU ME	Australia
			MT/HA			
2003	2.77	2.30	2.53	4.99	1.75	2.07
2010	2.90	2.46	2.78	5.32	1.85	2.34
2015	3.00	2.57	2.96	5.55	1.91	2.53
2020	3.09	2.68	3.14	5.78	1.98	2.72
2025	3.19	2.79	3.32	6.02	2.05	2.92
% Change: 1980-2001	15	21	31	21	17	41

Table 3.8. Estimated Corn Yields for Major Producing Countries

	United States	Mexico	China
	MT/HA		
2003	8.64	2.65	5.30
2010	9.44	3.08	5.94
2015	10.01	3.38	6.40
2020	10.58	3.69	6.86
2025	11.15	3.99	7.32
%Change 1980-2001	29	50	38

Table 3.9. Estimated Soybean yields for Major Exporting Countries/regions

	United States	Argentina	Brazil	Latin
		MT/HA		
2003	2.76	2.54	2.57	2.48
2010	3.03	2.71	2.87	2.81
2015	3.21	2.83	3.09	3.05
2020	3.40	2.95	3.30	3.28
2025	3.59	3.07	3.52	3.52
%Change: 1980-2001	30	21	37	42

Table 3.10. Estimated Percent Change (to 2025) in World Production

	Wheat	Corn	Soybean
		Percent Change	
United States	0.16	0.30	0.32
Canada	0.23	0.26	0.08
Europe	0.22	0.10	0.44
Australia	0.43	0.55	0.32
China	0.45	0.40	0.40
Japan	0.14	0.00	0.16
Argentina	0.33	0.53	0.22
Brazil	0.40	0.51	0.39
Mexico	0.12	0.53	0.03
South Korea	0.04	-0.15	0.10
Latin	0.43	0.27	0.45
N Africa	0.47	0.60	0.12
FSU_ME	0.18	-0.18	0.25
S Africa	0.02	0.18	0.37
S Asia	0.43	0.35	0.31
SEA	0.10	0.42	0.33
World	0.40	0.42	0.43

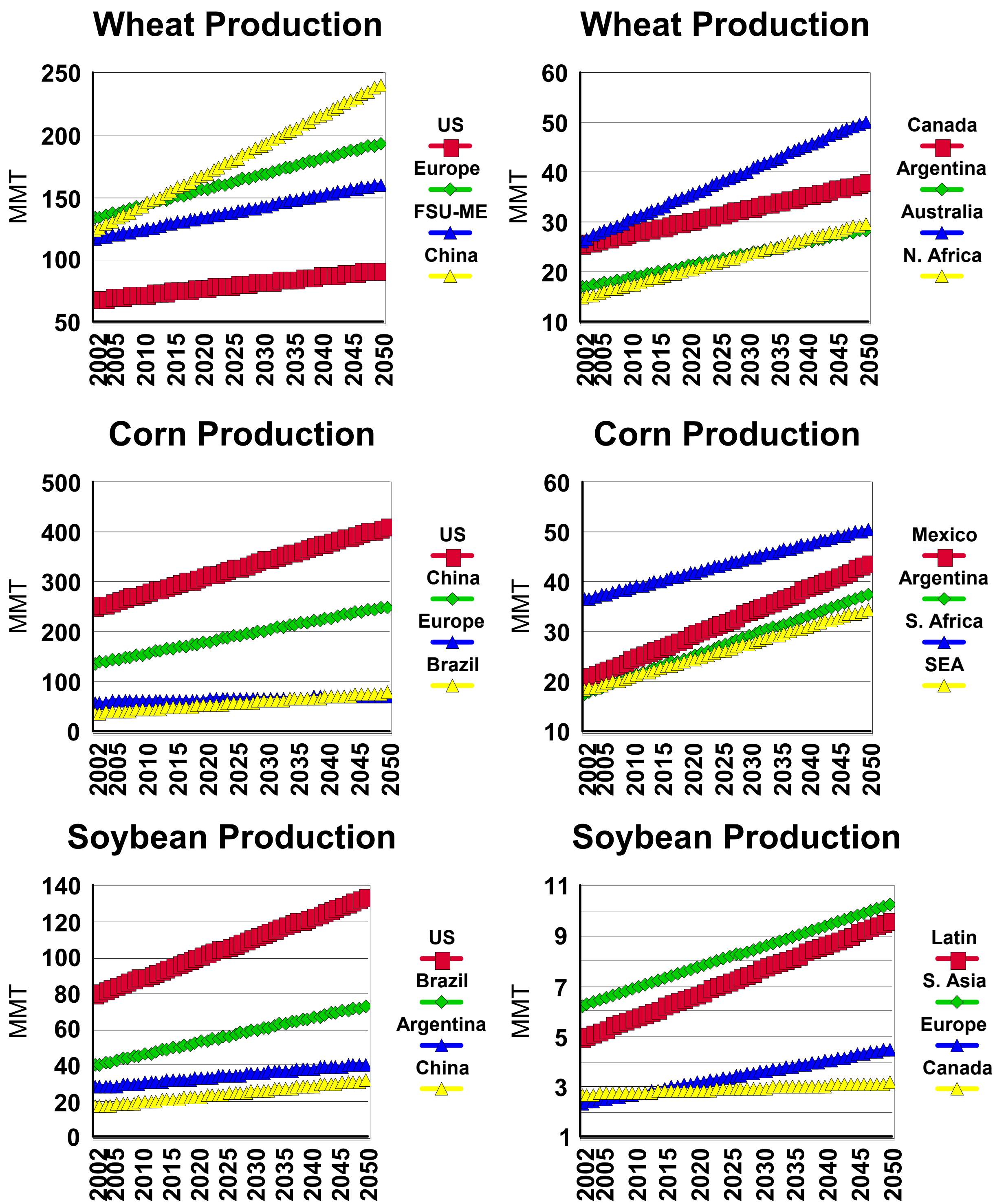


Figure 3.3.1 Forecast Production for Selected Producing Countries/Regions 2005-2050.

4. Production Costs in Major Producing and Exporting Regions

4.1 Data sources

Data on production costs for each country and crop were taken from Global Insights which uses a comparable methodology to derive production costs for each crop for each of the major projecting countries in the world. The value used in our analysis is defined as “Total Variable Costs” per hectare. These include costs for seed, chemical, herbicide, fuel, repairs, etc. These exclude fixed and economic costs such as land, interest on investment, depreciation, unpaid family labor, etc., which seems appropriate given the desire to use the direct production costs. Further, availability of variable costs was consistent across countries and regions, whereas, fixed and economic costs were not available for all countries and regions.

All values were published for years 1995 to 2025 and estimated assuming continuing trends to 2050. Costs of production were reported in $/hectare and utilized as such in the model (Tables 4.1.1 - 4.2.3). For comparison purposes, here they are converted to $/mt, using the yields estimated from the regression analysis for each country as described in Section 3 (Figures 4.1-4.3 and Tables 4.3.1 - 4.4.3). Finally, for the US different production regions were used (defined in Section 5).

4.2 Results

The results are summarized in Table 4.1.1-4.1.3 for current periods and in Tables 4.2.1-4.2.3 for future periods.

For wheat, low cost producers from the period 1995 to 2002 were Australia, Saskatchewan and several production regions within the U.S. (Central Plains, Northern Plains, Southern Plains).

For corn, low cost producers from 1995-2002 were U.S. producing regions, Argentina and Brazil. U.S. production regions have costs in the $35-$55/MT range, while China and the EU are $86 and 152$/MT, respectively.

Low cost producers for soybeans are the U.S. producing regions, EU and Argentina. Brazil’s costs are higher.

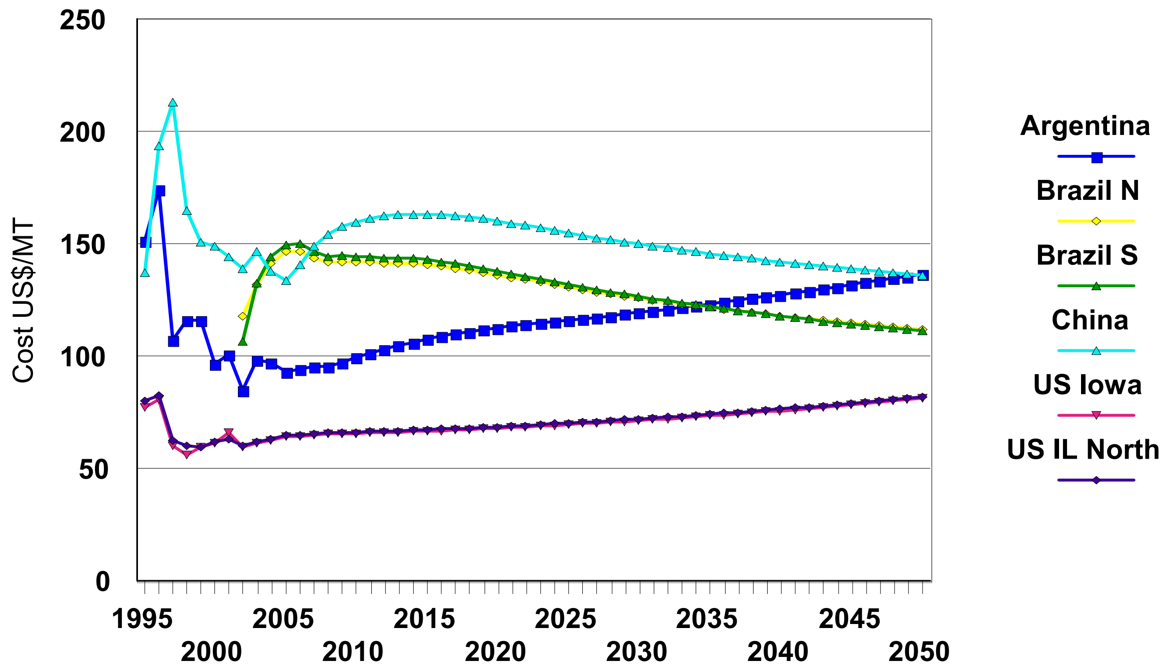


Figure 4.1 Soybean Cost of Production.

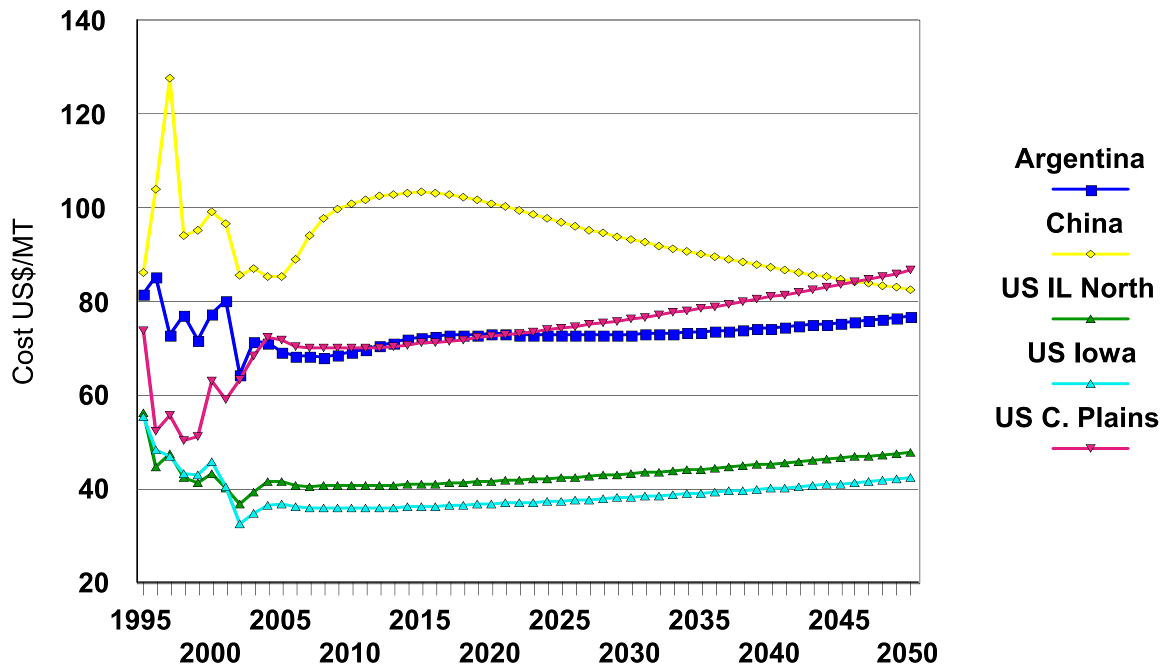


Figure 4.2 Corn Cost of Production.

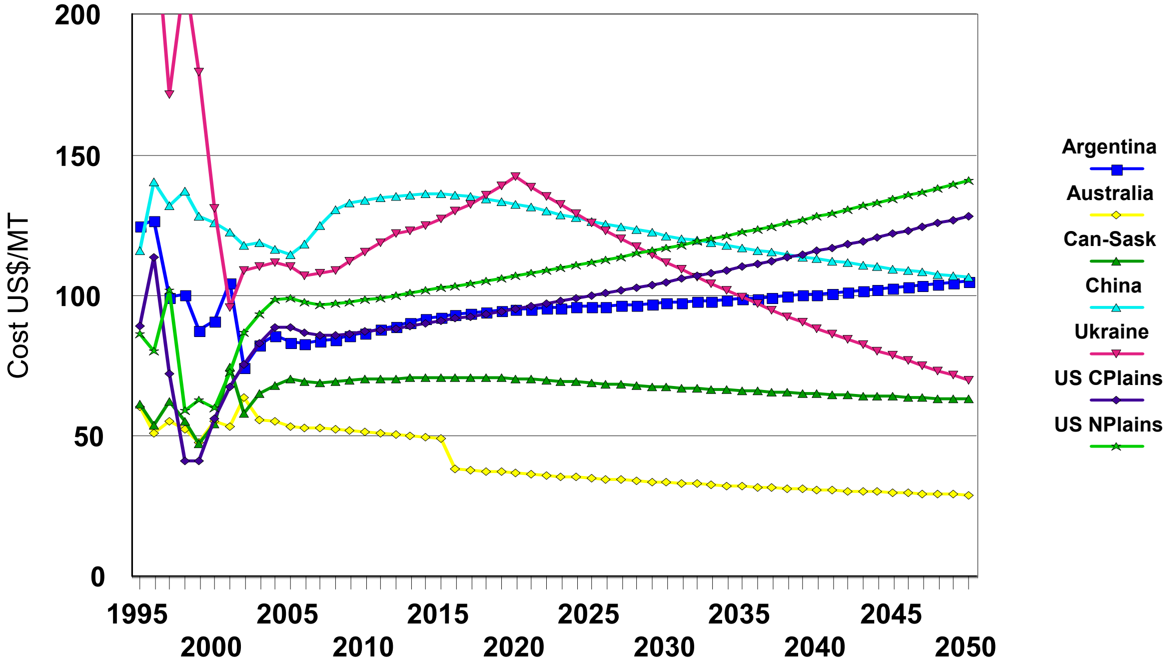


Figure 4.3 Wheat Cost of Production.

Table 4.1.1. Wheat Cost of Production ($/HA), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	238	284	259	243	224	235	241	186
Australia	108	107	101	98	97	101	102	130
Brazil N	339	339	330	319	197	279	252	244
Brazil S	339	339	330	319	197	279	252	244
Can Alb.	169	171	164	153	157	167	166	162
Can BC	169	171	164	153	157	167	166	162
Can Man	169	171	164	153	157	167	166	162
Can Ont	339	331	303	276	279	258	261	249
Can Sas	121	123	118	110	113	120	119	116
China	411	525	542	505	506	470	457	486
Europe	636	642	576	566	543	503	520	540
FSU-ME	460	352	291	315	289	204	183	189
Japan	800	900	1000	1100	1200	1300	1400	1500
Latin America	321	314	306	298	291	283	275	268
Mexico	744	757	830	741	710	827	898	854
North Africa	357	335	341	344	357	356	322	300
South Africa	244	220	214	188	175	166	148	134
South Asia	294	276	233	216	209	220	222	224
Korea	284	266	225	208	202	212	214	215
S. E. Asia	284	266	225	208	202	212	214	215
USCplains	175	178	192	123	119	127	145	127
USCplainsR	175	178	192	123	119	127	145	127
USDelta	174	177	191	122	119	126	145	127
USIllinoisN	225	233	191	189	180	186	209	177
USIllinoisS	225	233	191	189	180	186	209	177
USIndianaN	225	233	191	189	180	186	209	177
USIndianaR	225	233	191	189	180	186	209	177
USIowa	225	233	191	189	180	186	209	177
USIowaR	225	233	191	189	180	186	209	177
USMichigan	233	241	198	196	187	192	217	183
USMinnesota	160	169	161	129	123	132	144	126
USMinnesotaR	225	233	191	189	180	186	209	177
USMissouriR	225	233	191	189	180	186	209	177
USMissouriW	225	233	191	189	180	186	209	177
USNorthEast	233	241	198	196	187	192	217	183
USNPlains	160	169	161	129	123	132	144	126
USOhio	233	241	198	196	187	192	217	183
USPNW	327	357	351	284	273	288	305	296
USSouthEast	228	245	247	256	247	255	270	241
USSPlains	175	178	192	123	119	127	145	127
USWest	327	357	351	284	273	288	305	296
USWisconsin	233	241	198	196	187	192	217	183
USWisconsinW	233	241	198	196	187	192	217	183
USWNPlains	160	169	161	129	123	132	144	126

Table 4.1.2. Corn Cost of Production ($/HA), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	336	389	444	400	399	438	448	362
Australia	550	543	536	529	521	514	507	500
Brazil N	146	145	142	139	103	114	106	94
Brazil S	128	125	123	120	89	99	93	83
Can Alb.	684	643	620	571	556	564	561	519
Can BC	684	643	620	571	556	564	561	519
Can Man	684	643	620	571	556	564	561	519
Can Ont	476	447	431	397	387	393	390	361
Can Sas								
China	424	541	560	496	470	457	452	454
Europe	994	1020	875	861	824	746	783	812
FSU-ME	230	224	219	213	207	201	196	190
Japan	800	900	1000	1100	1200	1300	1400	1500
Latin America	418	483	551	497	495	543	556	449
Mexico	464	499	545	561	621	651	739	704
North Africa	520	503	486	469	451	434	417	400
South Africa	280	249	243	215	198	185	167	149
South Asia	254	231	215	221	189	200	184	201
Korea	240	234	227	221	214	208	201	195
S. E. Asia	240	234	227	221	214	208	201	195
USCplains	530	469	472	454	448	478	488	441
USCplainsR	530	469	472	454	448	478	488	441
USDelta	490	434	436	419	414	442	451	407
USIllinoisN	400	394	397	388	385	404	381	339
USIllinoisS	400	394	397	388	385	404	381	339
USIndianaN	400	394	397	388	385	404	381	339
USIndianaR	400	394	397	388	385	404	381	339
USIowa	400	394	397	388	385	404	381	339
USIowaR	400	394	397	388	385	404	381	339
USMichigan	358	365	372	361	364	386	401	375
USMinnesota	400	394	397	388	385	404	381	339
USMinnesotaR	400	394	397	388	385	404	381	339
USMissouriR	400	394	397	388	385	404	381	339
USMissouriW	400	394	397	388	385	404	381	339
USNorthEast	358	365	372	361	364	386	401	375
USNPlains	569	504	507	487	481	513	524	473
USOhio	358	365	372	361	364	386	401	375
USPNW	569	504	507	487	481	513	524	473
USSouthEast	440	410	411	381	383	414	407	377
USSPlains	530	469	472	454	448	478	488	441
USWest	569	504	507	487	481	513	524	473
USWisconsin	358	365	372	361	364	386	401	375
USWisconsinW	358	365	372	361	364	386	401	375
USWNPlains	569	504	507	487	481	513	524	473

Table 4.1.3. Soybeans Cost of Production ($/HA), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	314	315	301	284	287	256	261	214
Australia	600	586	571	557	543	529	514	500
Brazil N	437	445	440	424	315	348	314	284
Brazil S	437	443	436	420	316	348	306	277
Can Alb.								
Can BC								
Can Man								
Can Ont	260	268	250	221	227	222	221	205
Can Sas								
China	228	343	376	294	269	250	245	259
Europe	232	234	198	191	189	174	173	182
FSU-ME	250	241	233	224	216	207	199	190
Japan	3425	2994	2650	2442	2640	2910	2685	2578
Latin America	437	446	440	424	315	348	315	284
Mexico	800	786	771	757	743	729	714	700
North Africa	375	364	354	343	332	321	311	300
South Africa	420	384	371	323	303	287	257	237
South Asia	214	218	194	168	174	170	165	174
Korea	239	244	216	187	194	190	184	194
S. E. Asia	239	244	216	187	194	190	184	194
USCplains	194	207	180	173	173	172	187	179
USCplainsR	194	207	180	173	173	172	187	179
USDelta	220	238	218	220	212	222	239	234
USIllinoisN	227	238	195	194	187	187	197	195
USIllinoisS	227	238	195	194	187	187	197	195
USIndianaN	227	238	195	194	187	187	197	195
USIndianaR	227	238	195	194	187	187	197	195
USIowa	227	238	195	194	187	187	197	195
USIowaR	227	238	195	194	187	187	197	195
USMichigan	194	207	180	173	173	172	187	179
USMinnesota	193	205	179	171	171	171	185	177
USMinnesotaR	227	238	195	194	187	187	197	195
USMissouriR	227	238	195	194	187	187	197	195
USMissouriW	227	238	195	194	187	187	197	195
USNorthEast	194	207	180	173	173	172	187	179
USNPlains	193	205	179	171	171	171	185	177
USOhio	194	207	180	173	173	172	187	179
USPNW								
USSouthEast	251	262	234	240	230	236	268	250
USSPlains	182	193	168	161	161	161	174	167
USWest								
USWisconsin	194	207	180	173	173	172	187	179
USWisconsinW	194	207	180	173	173	172	187	179
USWNPlains	193	205	179	171	171	171	185	177

Table 4.2.1. Wheat Cost of Production ($/HA), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	186	241	299	340	388	442
Australia	130	121	100	104	108	113
Brazil N	244	326	362	390	420	452
Brazil S	244	326	362	390	420	452
Can Alb.	162	210	226	227	228	229
Can BC	162	210	226	227	228	229
Can Man	162	210	226	227	228	229
Can Ont	249	308	339	357	377	397
Can Sas	116	151	166	172	179	186
China	486	638	739	775	813	852
Europe	540	854	931	949	967	986
FSU-ME	189	213	252	265	279	294
Japan	1500	1500	1500	1500	1500	1500
Latin America	268	348	431	491	559	637
Mexico	854	846	902	922	941	961
North Africa	300	300	300	300	300	300
South Africa	134	201	244	331	449	609
South Asia	224	306	415	565	769	1047
Korea	215	286	348	397	453	517
S. E. Asia	215	286	348	397	453	517
USCplains	127	155	180	211	246	288
USCplainsR	127	155	180	211	246	288
USDelta	127	151	175	203	235	273
USIllinoisN	177	215	248	285	327	376
USIllinoisS	177	215	248	285	327	376
USIndianaN	177	215	248	285	327	376
USIndianaR	177	215	248	285	327	376
USIowa	177	215	248	285	327	376
USIowaR	177	215	248	285	327	376
USMichigan	183	222	254	291	334	383
USMinnesota	126	151	175	203	235	273
USMinnesotaR	177	215	248	285	327	376
USMissouriR	177	215	248	285	327	376
USMissouriW	177	215	248	285	327	376
USNorthEast	183	222	254	291	334	383
USNPlains	126	151	175	203	235	273
USOhio	183	222	254	291	334	383
USPNW	296	359	420	494	581	682
USSouthEast	241	293	341	396	460	534
USSPlains	127	155	180	211	246	288
USWest	296	359	420	494	581	682
USWisconsin	183	222	254	291	334	383
USWisconsinW	183	222	254	291	334	383
USWNPlains	126	151	175	203	235	273

Table 4.2.2. Corn Cost of Production ($/HA), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	362	459	579	673	782	908
Australia	500	500	500	500	500	500
Brazil N	94	124	138	145	152	160
Brazil S	83	108	120	127	135	143
Can Alb.	519	654	697	704	710	716
Can BC	519	654	697	704	710	716
Can Man	519	654	697	704	710	716
Can Ont	361	455	485	489	494	498
Can Sas						
China	454	610	703	734	768	802
Europe	812	1310	1399	1400	1402	1403
FSU-ME	190	220	260	260	260	260
Japan	1500	1500	1500	1500	1500	1500
Latin America	449	570	719	835	970	1127
Mexico	704	700	761	793	825	859
North Africa	400	400	400	400	400	400
South Africa	149	225	270	357	472	624
South Asia	201	230	270	309	353	404
Korea	195	259	315	360	410	468
S. E. Asia	195	259	315	360	410	468
USCplains	441	540	626	729	848	987
USCplainsR	441	540	626	729	848	987
USDelta	407	490	600	683	777	884
USIllinoisN	339	414	475	546	628	721
USIllinoisS	339	414	475	546	628	721
USIndianaN	339	414	475	546	628	721
USIndianaR	339	414	475	546	628	721
USIowa	339	414	475	546	628	721
USIowaR	339	414	475	546	628	721
USMichigan	375	461	532	616	712	825
USMinnesota	339	414	475	546	628	721
USMinnesotaR	339	414	475	546	628	721
USMissouriR	339	414	475	546	628	721
USMissouriW	339	414	475	546	628	721
USNorthEast	375	461	532	616	712	825
USNPlains	473	560	630	713	806	911
USOhio	375	461	532	616	712	825
USPNW	473	560	630	713	806	911
USSouthEast	377	462	534	619	717	831
USSPlains	441	540	626	729	848	987
USWest	473	560	630	713	806	911
USWisconsin	375	461	532	616	712	825
USWisconsinW	375	461	532	616	712	825
USWNPlains	473	560	630	713	806	911

Table 4.2.3. Soybeans Cost of Production ($/HA), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	214	269	333	382	439	504
Australia	500	500	500	500	500	500
Brazil N	284	388	427	447	468	489
Brazil S	277	427	469	487	506	526
Can Alb.						
Can BC						
Can Man						
Can Ont	205	255	270	270	271	271
Can Sas						
China	259	339	392	415	440	466
Europe	182	287	300	294	289	283
FSU-ME	190	220	260	260	260	260
Japan	2578	3460	3891	3904	3916	3929
Latin America	284	357	442	507	582	669
Mexico	700	700	760	801	843	888
North Africa	300	300	300	300	300	300
South Africa	237	347	422	569	767	1034
South Asia	174	199	233	267	305	349
Korea	194	239	284	324	370	422
S. E. Asia	194	239	284	324	370	422
USCplains	179	218	253	295	344	401
USCplainsR	179	218	253	295	344	401
USDelta	234	283	328	381	443	515
USIllinoisN	195	239	279	325	379	443
USIllinoisS	195	239	279	325	379	443
USIndianaN	195	239	279	325	379	443
USIndianaR	195	239	279	325	379	443
USIowa	195	239	279	325	379	443
USIowaR	195	239	279	325	379	443
USMichigan	179	218	253	295	344	401
USMinnesota	177	218	253	295	344	401
USMinnesotaR	195	239	279	325	379	443
USMissouriR	195	239	279	325	379	443
USMissouriW	195	239	279	325	379	443
USNorthEast	179	218	253	295	344	401
USNPlains	177	218	253	295	344	401
USOhio	179	218	254	296	344	400
USPNW						
USSouthEast	250	308	360	419	489	570
USSPlains	167	218	254	296	344	400
USWest						
USWisconsin	179	218	254	296	344	400
USWisconsinW	179	218	254	296	344	400
USWNPlains	177	218	253	295	344	401

Table 4.3.1. Wheat Cost of Production ($/MT), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	125	127	100	95	88	91	104	74
Australia	60	51	55	48	48	55	53	64
Brazil N	253	214	231	183	115	271	147	148
Brazil S	225	190	205	163	102	240	131	131
Can Alb.	71	67	73	56	58	65	81	74
Can BC	66	62	67	52	53	60	75	68
Can Man	71	67	73	56	58	65	81	74
Can Ont	84	76	79	59	60	59	75	64
Can Sas	62	58	63	48	50	56	70	61
China	116	141	132	128	128	126	123	118
Europe	136	131	121	115	110	101	108	109
FSU-ME	313	238	171	196	179	131	96	109
Japan	272	299	276	319	348	346	380	412
Latin America	145	119	126	117	114	101	102	103
Mexico	200	197	183	155	149	171	191	197
North Africa	210	153	180	182	189	212	160	140
South Africa	76	76	74	62	57	55	50	43
South Asia	125	121	96	90	87	85	87	85
Korea	57	72	45	70	67	106	71	76
S. E. Asia	265	248	250	188	182	191	193	171
USCplains	119	120	119	70	68	73	88	76
USCplainsR	77	78	77	45	44	48	57	49
USDelta	77	77	77	45	44	48	57	49
USIllinoisN	64	65	49	45	43	45	53	44
USIllinoisS	87	89	67	62	59	62	72	60
USIndianaN	69	71	53	49	46	49	57	48
USIndianaR	89	91	69	63	60	63	73	61
USIowa	91	93	70	64	61	64	75	63
USIowaR	87	89	67	62	59	62	72	60
USMichigan	60	62	47	43	41	43	50	42
USMinnesota	89	93	81	60	57	63	71	62
USMinnesotaR	117	120	90	83	79	83	97	81
USMissouriR	88	90	68	62	59	62	73	61
USMissouriW	103	105	79	73	69	73	85	71
USNorthEast	70	72	54	50	47	50	58	49
USNPlains	126	131	115	85	81	89	101	87
USOhio	68	69	52	48	46	48	56	47
USPNW	104	112	101	76	73	78	86	82
USSouthEast	127	136	125	120	116	122	134	118
USSPlains	210	212	209	124	120	129	155	134
USWest	109	118	106	80	77	82	91	87
USWisconsin	71	72	55	50	48	50	59	49
USWisconsinW	90	92	70	64	61	64	75	62
USWNPlains	143	149	130	96	92	100	114	99

Table 4.3.2. Corn Cost of Production ($/MT), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	82	85	73	72	72	78	80	65
Australia	99	91	112	88	87	109	99	84
Brazil N	63	57	55	56	41	36	37	34
Brazil S	52	46	44	45	34	29	30	26
Can Alb.	122	119	113	92	89	110	109	93
Can BC								
Can Man	147	144	136	111	108	133	131	113
Can Ont	65	63	60	49	47	58	58	48
Can Sas								
China	86	104	128	100	107	99	97	86
Europe	192	187	137	139	133	143	131	152
FSU-ME	80	83	63	82	80	73	75	68
Japan	400	900	1000	1100	304	1300	1400	509
Latin America	221	252	286	261	261	279	287	224
Mexico	204	217	232	212	235	276	307	266
North Africa	124	94	90	78	75	74	69	66
South Africa	170	167	173	138	127	133	115	97
South Asia	161	140	128	128	110	113	106	112
Korea	62	58	55	56	98	52	47	49
S. E. Asia	127	117	110	101	43	94	90	86
USCplains	92	73	74	67	66	69	70	63
USCplainsR	105	83	84	76	75	78	79	72
USDelta	81	64	65	59	58	61	61	56
USIllinoisN	53	46	47	43	43	44	41	37
USIllinoisS	70	61	62	57	57	58	54	49
USIndianaN	63	56	56	52	52	53	49	44
USIndianaR	84	74	75	69	69	70	66	59
USIowa	47	41	41	38	38	39	36	33
USIowaR	49	43	44	41	40	41	39	34
USMichigan	67	61	62	57	57	60	61	57
USMinnesota	55	49	49	45	45	46	43	39
USMinnesotaR	52	45	46	42	42	43	40	36
USMissouriR	86	75	76	71	70	72	67	60
USMissouriW	74	65	65	61	60	62	58	51
USNorthEast	154	140	143	132	133	138	142	133
USNPlains	148	117	118	108	106	111	112	102
USOhio	85	78	79	73	73	76	78	74
USPNW	172	137	138	125	124	129	130	118
USSouthEast	109	90	91	80	80	85	82	77
USSPlains	106	84	84	77	76	79	80	73
USWest	222	176	178	162	160	167	169	153
USWisconsin	65	59	61	56	56	58	60	56
USWisconsinW	63	58	59	54	55	57	58	55
USWNPlains	266	211	213	193	191	199	202	183

Table 4.3.3. Soybeans Cost of Production ($/MT), 1995-2002

	1995	1996	1997	1998	1999	2000	2001	2002
Argentina	151	174	108	115	121	97	101	85
Australia	263	272	319	253	247	252	245	227
Brazil N	208	202	185	177	116	131	121	122
Brazil S	193	186	170	162	107	121	109	102
Can Alb.								
Can BC								
Can Man								
Can Ont	93	107	97	80	82	88	140	81
Can Sas								
China	137	194	214	164	156	150	144	139
Europe	85	82	63	67	75	77	62	62
FSU-ME	298	306	259	231	222	180	203	179
Japan	1980	1664	1514	1412	1985	1524	1428	1456
Latin America	206	201	186	179	127	141	133	117
Mexico	559	672	521	485	302	536	489	490
North Africa	160	146	138	137	133	132	249	122
South Africa	369	346	323	223	209	201	186	184
South Asia	231	266	202	182	189	189	172	178
Korea	158	150	139	141	162	145	141	130
S. E. Asia	203	197	177	156	109	152	153	148
USCplains	96	96	80	82	130	79	82	77
USCplainsR	109	109	92	93	148	89	93	87
USDelta	121	122	109	116	177	113	117	112
USIllinoisN	80	79	63	66	101	62	62	60
USIllinoisS	107	105	83	88	133	82	82	80
USIndianaN	91	89	70	74	113	69	70	68
USIndianaR	120	118	94	100	151	92	93	90
USIowa	80	78	62	66	100	61	62	60
USIowaR	82	80	64	67	102	63	63	61
USMichigan	86	86	73	74	117	71	74	69
USMinnesota	84	84	70	72	113	69	72	67
USMinnesotaR	82	80	64	67	102	63	63	61
USMissouriR	104	102	81	86	130	79	80	78
USMissouriW	119	117	93	98	149	91	92	89
USNorthEast	135	135	113	116	184	111	116	108
USNPlains	107	107	90	92	145	88	91	86
USOhio	104	104	88	89	142	86	89	84
USPNW								
USSouthEast	164	162	139	152	230	143	157	143
USSPlains	126	126	106	108	171	104	108	101
USWest								
USWisconsin	78	78	65	67	105	64	66	62
USWisconsinW	73	73	61	62	99	60	62	58
USWNPlains								

Table 4.4.1. Wheat Cost of Production ($/MT), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	74	87	95	98	101	105
Australia	64	52	37	34	31	29
Brazil N	148	174	167	159	153	149
Brazil S	131	153	147	140	135	132
Can Alb.	74	89	87	89	84	78
Can BC	68	81	80	82	77	72
Can Man	74	89	87	89	84	78
Can Ont	64	73	74	79	78	77
Can Sas	61	74	74	79	76	74
China	118	134	132	121	113	107
Europe	109	161	161	152	144	137
FSU-ME	109	115	127	125	124	123
Japan	412	393	371	351	333	318
Latin America	103	117	125	124	126	129
Mexico	197	187	190	186	181	177
North Africa	140	121	102	89	79	71
South Africa	43	64	78	105	141	190
South Asia	85	102	118	141	171	210
Korea	76	99	119	134	151	169
S. E. Asia	171	219	256	282	308	340
USCplains	76	72	79	108	118	132
USCplainsR	49	47	51	70	77	85
USDelta	49	46	50	67	74	81
USIllinoisN	44	42	45	61	66	72
USIllinoisS	60	57	62	83	90	98
USIndianaN	48	45	49	66	71	77
USIndianaR	61	58	63	84	91	100
USIowa	63	60	65	87	94	102
USIowaR	60	57	62	83	90	98
USMichigan	42	40	42	57	61	67
USMinnesota	62	58	63	85	93	102
USMinnesotaR	81	77	84	111	121	132
USMissouriR	61	58	63	83	91	99
USMissouriW	71	68	73	98	106	115
USNorthEast	49	46	49	66	71	78
USNPlains	87	82	89	120	131	144
USOhio	47	44	48	64	69	75
USPNW	82	78	86	118	131	146
USSouthEast	118	113	123	166	182	201
USSPlains	134	127	139	188	209	230
USWest	87	83	91	124	138	153
USWisconsin	49	46	50	66	72	78
USWisconsinW	62	59	63	84	91	99
USWNPlains	99	93	101	135	149	163

Table 4.4.2. Corn Cost of Production ($/MT), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	65	69	73	73	74	77
Australia	84	74	63	54	48	43
Brazil N	34	39	36	33	30	28
Brazil S	26	31	29	25	23	22
Can Alb.	93	107	104	75	70	65
Can BC						
Can Man	113	131	126	92	85	80
Can Ont	48	56	54	39	36	34
Can Sas						
China	86	101	101	93	87	83
Europe	152	238	243	234	226	218
FSU-ME	68	84	108	119	131	148
Japan	509	509	509	509	509	509
Latin America	224	260	296	314	336	360
Mexico	266	223	203	182	166	154
North Africa	66	54	45	38	33	29
South Africa	97	138	154	191	236	294
South Asia	112	114	118	121	125	131
Korea	49	69	90	111	137	171
S. E. Asia	86	100	105	105	107	110
USCplains	63	61	63	57	60	64
USCplainsR	72	69	72	65	69	73
USDelta	56	52	57	51	52	55
USIllinoisN	37	35	36	32	34	36
USIllinoisS	49	47	48	43	45	47
USIndianaN	44	42	43	39	40	43
USIndianaR	59	56	58	51	54	57
USIowa	33	31	32	28	30	32
USIowaR	34	33	34	30	32	33
USMichigan	57	55	57	51	54	58
USMinnesota	39	37	38	34	35	37
USMinnesotaR	36	34	35	31	33	35
USMissouriR	60	57	59	52	55	58
USMissouriW	51	49	51	45	47	50
USNorthEast	133	128	132	119	125	133
USNPlains	102	94	95	83	86	89
USOhio	74	71	73	65	69	74
USPNW	118	110	110	97	100	104
USSouthEast	77	74	76	68	72	77
USSPlains	73	70	72	65	69	74
USWest	153	141	142	125	129	134
USWisconsin	56	54	56	50	53	56
USWisconsinW	55	53	54	49	51	55
USWNPlains	183	170	170	149	154	160

Table 4.4.3. Soybeans Cost of Production ($/MT), 2002-2050

	2002	2010	2020	2030	2040	2050
Argentina	85	99	113	120	128	137
Australia	227	205	182	164	149	137
Brazil N	122	146	140	130	122	115
Brazil S	102	150	143	121	113	106
Can Alb.						
Can BC						
Can Man						
Can Ont	81	97	100	97	94	91
Can Sas						
China	139	160	161	150	142	136
Europe	62	86	77	66	58	51
FSU-ME	179	191	205	188	175	162
Japan	1456	1850	1956	1850	1756	1672
Latin America	117	127	135	135	138	142
Mexico	490	483	517	537	558	581
North Africa	122	117	112	106	102	97
South Africa	184	238	254	304	369	454
South Asia	178	184	191	198	206	216
Korea	130	154	175	192	211	232
S. E. Asia	148	164	173	177	183	191
USCplains	77	84	87	73	77	82
USCplainsR	87	95	99	82	87	93
USDelta	112	122	126	105	110	117
USIllinoisN	60	66	69	58	61	65
USIllinoisS	80	88	91	76	81	87
USIndianaN	68	75	77	65	69	73
USIndianaR	90	100	103	86	91	98
USIowa	60	66	68	57	60	65
USIowaR	61	67	70	58	62	66
USMichigan	69	76	79	66	70	74
USMinnesota	67	74	77	64	68	73
USMinnesotaR	61	67	70	58	62	66
USMissouriR	78	86	89	74	79	84
USMissouriW	89	98	102	85	90	96
USNorthEast	108	118	122	102	108	116
USNPlains	86	94	98	81	86	92
USOhio	84	92	95	79	84	89
USPNW						
USSouthEast	143	158	164	137	145	155
USSPlains	101	119	123	103	109	116
USWest						
USWisconsin	62	68	71	59	62	66
USWisconsinW	58	64	66	55	58	62
USWNPlains						

5. U.S. Domestic Production and Consumption

5.1 Regional definitions for production and consumption The United States was divided into 10 consumption regions and 24 production regions. Production regions mirrored consumption regions, except several were further divided to groups of states, states, or crop reporting districts adjacent to the Mississippi and Ohio rivers. Regions are shown in Figure 5.1 and 5.2 for production and consumption respectively.

5.2 Method and Data Sources In most cases statistics on domestic consumption of grains by state do not exist, at least publicly. Thus, we derived a method to allocate consumption to the respective regions. To calculate consumption for the U.S. regions, total consumption (estimated along with consumption for international regions) was allocated to domestic consumption regions by crop on a percentage basis. The percentages for implied domestic consumption for each region were estimated as:

Production in consumption region i - rail shipments from domestic consumption region i to export, - rail shipments from domestic consumption region i to other domestic consumption regions j where j$\neq$i, + rail shipments from domestic regions j to domestic region i. Implied domestic consumption numbers were summed across regions and utilized to estimate the percentage of demand by region. These percentages were utilized to allocate total estimated U.S. for each crop to the respective U.S. demand regions.

$$DC_i = [(PRODi - RAILEXP_i - \sum_{j=1}^{n}(RAILDOM_{ij} - RAILDOM_{ji})] / TOTALCONS$$

where

Prodi is production in consumption region i,
railexpi is export rail shipments from region i to ports,
RailDOMij is rail shipments from consumption region i to region j where j$\neq$i, and
RAILDOMji is rail shipments from consumption regions j to region i and
TOTALCONS is total US implied consumption.

5.3 US domestic consumption The results are shown in Table 5.1. Casual comparison to observe production and consumption suggests these are reflective of actual consumption. To estimate the quantity of consumption for each region, the annual consumption for the entire United States estimated in Section 3 above was applied to these values. These were taken as the estimated level of consumption by region.

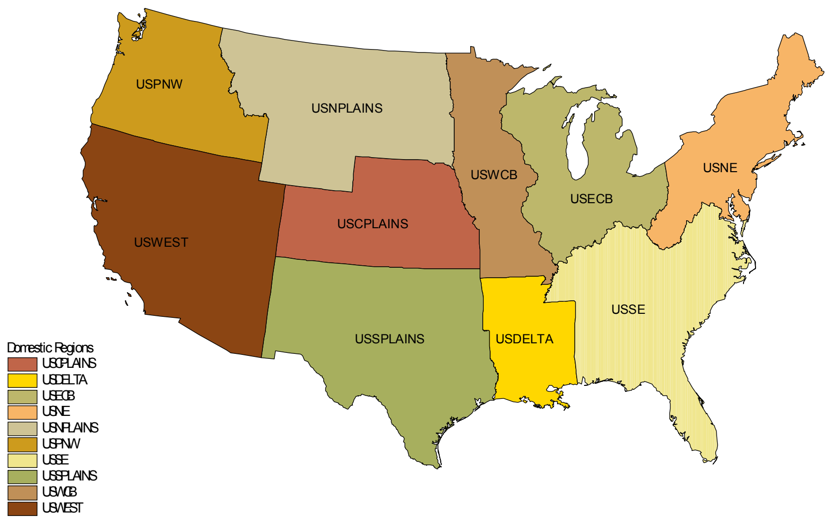


Figure 5.1. U.S. Consumption Regions.

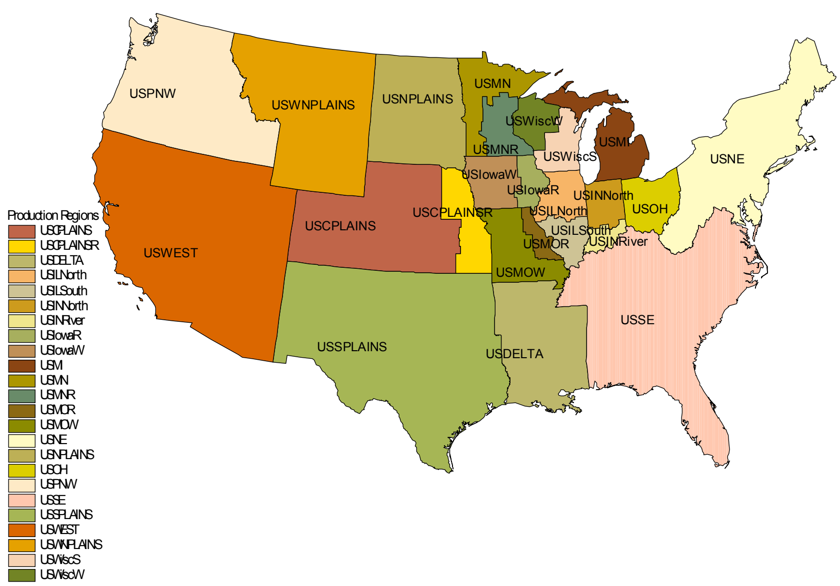


Figure 5.2. U.S. Production Regions.

5.4 Ethanol Additional demand was added to U.S. domestic consumption to reflect added corn demand for expanded ethanol production. To arrive at an estimate of the additional demand, existing capacities for ethanol plants were obtained from Renewable Fuels Association Ethanol Industry Outlook (2004). This totaled 3,101 million gallons of ethanol per year.

Then estimates for current production and planned expansion were obtained from Renewable Fuels Association (2005). These total 4,398 million gallons of ethanol per year. Changes in production capacity including planned expansion were estimated from those existing in January of 2004 and allocated to consumption regions. These were derived to allocate the proportion of future capacity to consumption regions. Most of planned expansions are in the western (43%) and eastern (27%) corn belt regions and the Central (15%) and Northern Plains (11%).

Proportions of increases in ethanol capacity were applied to estimate of change in ethanol production, 2004 to 2010 (ProExporter (2005) estimated production at 6.29 billion gallons/year in 2010) and converted back to additional corn demand assuming 2.7 gallons of ethanol per bushel of corn and assuming dry mill production of ethanol which results in production of 18 lbs of DDG/bu of corn. Following Proexporter's (2004) estimate of current displacement of corn by DDG (market assessment of demand), an amount of feed corn demand equal to 22% of corn milled for ethanol was displaced by DDG over the period 2002-2004. This rate of displacement was applied for increases in corn demand for ethanol. The added demand was then adjusted to reflect the displacement of corn demand as feed by DDG.

The added demand for corn amounts to 921 million bu of corn per year or 23.4 Mmt (Table 5.2). This added demand for ethanol was added to consumption for years 2010-2050 based on the proportions for plant expansion in each region estimated above. Ethanol production from corn is not expected to increase beyond this level to 2050 (see U.S. Department of Energy Scenarios, (Steiner)). If ethanol production increases beyond these levels, Steiner suggests that source of feedstock for production would shift from starch to cellulosic with increases above current levels from cellulosic rather than starch (corn, sorghum, wheat, etc.).

The rate of adoption of DDG for corn is a lot less than the rate of substitution in corn rations (i.e., a lot more corn could be displaced with wider adoption of DDG for livestock ratios). The substitition rate of DDG for corn in livestock is 40 lbs. of corn is displaced by 400 lbs. of DDG and for swine and poultry, 177 lbs. of corn is displaced by 200 lbs. of DDG (Urbanchuk). An article covering the effect of ethanol on Iowa indicated DDG are largely fed to cattle and that Swine and Poultry are largely untapped markets (Otto and Gallagher, 2003).

Steiner examined effects of cellulosic production of ethanol to 2050. This study has two scenarios which both indicate growth in ethanol production from 2010 to 2050 growing to 49.3 to 50.4 billion gallons, of which, most of growth past 2010 is in ethanol produced from cellulosic feedstocks rather than starch based (corn, sorghum). These are tied back to US Department of Energy scenarios forecast to 2050. This suggests, corn demand for ethanol beyond 2010 would be somewhat stable to 2050 with increases in ethanol production coming from other feedstocks.

ProExporter (2005) identified problems on the horizon for ethanol as the inability to market ethanol outside of the oxygenate market where demand totals 4 billion gallons. However, they expected ethanol demand to continue to increase.

Table 5.1 Percent of U.S. Consumption by Crop and Region, 2002.

	Crop		
Region	Corn	Wheat	Soybeans
US Central Plains	14.36%	17.58%	7.86%
US Delta	2.46%	3.91%	6.28%
US Eastern Corn Belt	31.76%	11.09%	36.25%
US North East	1.93%	3.72%	1.23%
US Northern Plains	4.50%	17.99%	6.20%
US Pacific North West	0.55%	17.44%	0.00%
US South East	5.40%	6.82%	6.89%
US Southern Plains	3.97%	11.05%	0.91%
US Western Corn Belt	33.52%	6.23%	34.30%
US West	1.54%	4.15%	0.08%

Table 5.2 Calculation of Increased Corn Consumption for Ethanol by Region to 2010

Region	*Forecast Expansion in Ethanol Capacity*	*Expansion Corn Equivalent*	*DDG Produced*	*Corn Displaced*	*Net Added Corn Demand*	
	Mil Gal	*Mil bu*	*(000) Tons*	*Mil bu*	*Mil bu*	*TMT*
CPlains	339	126	1,130	28	98	2,489
Delta	0	0	0	0	0	0
E. Corn B.	553	205	1,842	45	160	4,058
Northeast	0	0	0	0	0	0
NPlains	194	72	647	16	56	1,425
PNW	(10)	(4)	(33)	(1)	(3)	(72)
Southeast	58	21	192	5	17	422
SPlains	111	41	368	9	32	812
W. Corn B.	1,944	720	6,480	158	592	14,274
West	(3)	(1)	(8)	0	(1)	(18)
Total	3,185	1,180	10,617	259	921	23,388

6. Modal Rates/Cost Analysis

6.1 Regions and Logic Demand regions were defined to allow for estimation of domestic consumption by region as made up of groups of states from which we could use rail shipment data and production to calculate percent of demand by region. Smaller aggregations for demand regions would complicate allocations of total demand substantially. Consumption regions are shown in Figure 6.1.1.

Production regions were defined to accommodate potential diverse flows within the United States. See Figure 6.1.2. Specifically, the Northern Plains region was split into a Western Northern Plains (Montana and Wyoming) and a Northern Plains region (North and South Dakota). Another existing region (Central Plains) has crop reporting districts (CRD's) close to the Missouri River separated to form a new Central Plains River region. In the eastern and western corn belt regions, production regions were defined first at the state level and further refined to specify CRD's adjacent to the river system as separate production regions. These type of adjustments were made in several states within the old Eastern and Western Corn Belt Regions.

The rationale for changes were to more accurately reflect tradeoffs between truck/rail shipping costs to barge movements and to reflect limits on production available via trucks from nearby production areas for feeding barge loading facilities.

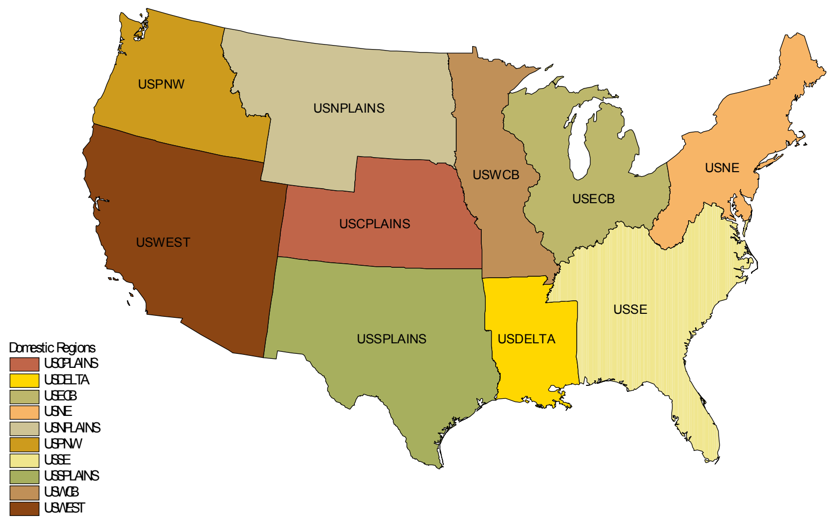


Figure 6.1.1. U.S. Consumption Regions.

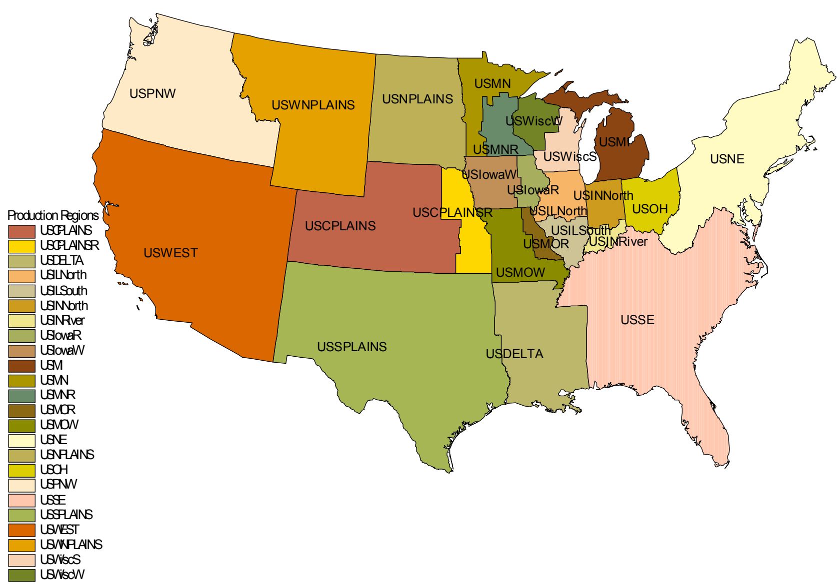


Figure 6.1.2. U.S. Production Regions.

6.2 US Rail Rail rate matrixes were estimated with data from the Surface Transportation Board Confidential Waybill data set. This data was for the years 1995-2002 and was assembled by the Tennessee Valley Associates (TVA).

Two matrixes were derived for each crop. First was a shipping matrix from production regions to export and barge loading locations. These included export destinations of Duluth/Superior, Pacific Northwest, Northern Louisiana, Texas Gulf, East Coast of US, Toledo, and for direct rail shipment to Mexico. Six barge loading regions (reaches) were included: Reach 1 - Cairo - LaGrange (St. Louis); Reach 2 - LaGrange to McGregor (Davenport); Reach 3- McGregor to Mpls (Mpls); Reach 4-Illinois River (Peoria); Reach 5 Cairo to Louisville (Louisville); and Reach 6 Cincinnati (Cincinnati). The second rail rate matrix was from production regions to domestic consumption regions.

Two data sets were constructed which included year, commodity, origin region (production region), destination (export port area or barge loading area for export and domestic region for domestic), total revenue and total tons by shipment. A shipping rate in $/MT was calculated for each shipment. Then weighted average rates by year (individual observations for $/MT were weighted by the tons shipped) were estimated for each year, crop and movement. The results are shown in Table 6.2.1-6.2.6.

Rail rates obtained from the Confidential Waybill data have missing rates (0 value) for movements which may or may not exist in the years 1995-2002 or may be sporadic (in one year, out the next). In order to have a consistent data set for future projections, rail rate relationships were estimated using the data from 1995 to 2002. These relationships were used to fill in for missing rate observations for the 2002 data set. Relationships were estimated to examine effects of distance, crude oil prices (West Texas Intermediate from Global Insights), PNW-Gulf price spreads, 2004), distance to nearest barge loading facility, barge transportation index (ProExporter or AMS), etc. on rail rates. Data on rail rates, crude oil prices, price spreads for each of the years were first converted to real 2000 dollars to remove effects of inflation using the WEFA GDP deflator.

Statistical relationships were estimated for each of the three grains for both domestic shipments and for shipments to export and barge locations (3 grains • 2 destination groups (Domestic + Export &Barge=6). Statistically significant effects were largely those related to functional forms of distance, distance to nearest barge loading location, and price spreads, yet estimated relationships varied by crop and whether data were estimated for domestic or export&barge movements. Estimated relationships are in Table 6.2.7. Inclusion of crude oil prices did not increase the statistical significance of the models so this variable was not included.

These rate relationships were used to forecast rates for those missing observations within the 2002 data set. Thus, the revised data set for forecasting includes available rates for 2002 and estimated rates for those observations that were missing. These results are shown in Tables 6.2.8-6.2.13.

Table 6.2.1 Rail Rates for Corn from U.S. Production Regions to U.S. Export and Barge Loading Regions, 2002 ($/MT).

ProdReg	DulSup	EastCo	Mexico	NOLA	PNW	TexasG	Toledo	Reach1	Reach2	Reach3	Reach4
USCPLAINS	0.00	0.00	35.06	27.81	28.05	43.03	0.00	13.50	0.00	0.00	0.00
USCPLAINSR	0.00	0.00	37.17	21.24	24.34	21.15	0.00	0.00	0.00	0.00	0.00
USDELTA	0.00	0.00	0.00	6.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USILNorth	0.00	15.21	28.33	10.49	0.00	0.00	0.00	3.98	0.00	0.00	5.75
USILSouth	0.00	16.81	0.00	9.22	0.00	0.00	0.00	3.27	0.00	0.00	2.67
USINNorth	0.00	14.31	0.00	0.00	0.00	0.00	0.00	4.30	0.00	0.00	6.25
USIowaR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.76	5.14	0.00	7.84
USIowaW	0.00	0.00	32.62	21.61	0.00	22.79	0.00	13.15	13.25	0.00	9.64
USMI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.51	0.00	0.00	12.51
USMN	0.00	0.00	33.50	0.00	25.59	25.53	0.00	13.00	8.89	10.32	12.01
USMNR	7.94	0.00	43.05	25.86	26.47	0.00	0.00	11.29	8.00	7.34	10.98
USMOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10	0.00	0.00	0.00
USMOW	0.00	0.00	35.25	18.51	35.39	0.00	0.00	5.81	0.00	0.00	0.00
USNPLAINS	13.26	0.00	39.49	0.00	25.03	0.00	0.00	19.20	0.00	14.66	0.00
USOH	0.00	18.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USSE	0.00	0.00	0.00	6.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USSPLAINS	0.00	0.00	6.75	0.00	0.00	11.06	0.00	0.00	0.00	0.00	0.00
USWiscS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.59	0.00	0.00	7.41

Note: Rate of 0 implies no reported movement.

Table 6.2.2. Rail Rates for Wheat from U.S. Production Regions to U.S. Export and Barge Loading Regions, 2002 ($/MT).

ProdReg	DulSup	EastCo	Mexico	NOLA	PNW	TexasG	Toledo	Reach1	Reach2	Reach3	Reach4
USCPLAINS	56.35	0.00	27.08	22.92	35.38	22.33	0.00	17.98	20.96	26.21	19.26
USCPLAINSR	0.00	0.00	0.00	21.25	0.00	18.41	0.00	14.05	0.00	24.30	15.30
USDELTA	0.00	0.00	18.02	8.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USILNorth	0.00	0.00	22.06	9.43	0.00	20.60	10.12	11.38	0.00	0.00	10.97
USILSouth	0.00	0.00	0.00	0.00	0.00	0.00	10.91	5.77	0.00	0.00	0.00
USINNorth	0.00	13.80	0.00	0.00	0.00	0.00	0.00	10.78	0.00	0.00	0.00
USINRiver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.82	0.00	0.00	0.00
USMI	0.00	20.52	35.00	0.00	0.00	0.00	5.34	11.60	0.00	0.00	8.59
USMN	13.37	0.00	0.00	0.00	37.58	24.88	0.00	18.99	0.00	16.20	20.28
USMNR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.29	0.00	6.25	9.51
USMOW	0.00	0.00	0.00	23.33	0.00	18.36	0.00	10.51	0.00	0.00	0.00
USNE	0.00	11.66	0.00	0.00	0.00	0.00	19.73	42.00	0.00	0.00	48.50
USNPLAINS	21.84	0.00	0.00	33.53	47.45	31.91	0.00	28.70	0.00	26.40	25.70
USOH	0.00	15.18	0.00	11.75	0.00	0.00	4.68	13.57	0.00	0.00	13.07
USPNW	0.00	0.00	0.00	0.00	14.13	32.05	0.00	26.12	0.00	27.83	0.00
USSE	0.00	11.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USSPLAINS	0.00	0.00	25.05	18.82	0.00	18.89	0.00	31.98	0.00	0.00	31.98
USWEST	0.00	0.00	0.00	0.00	26.31	26.81	0.00	38.66	0.00	0.00	40.23
USWiscS	0.00	0.00	28.17	0.00	0.00	0.00	0.00	10.96	0.00	0.00	8.08
USWiscW	0.00	0.00	0.00	30.20	0.00	0.00	0.00	10.03	0.00	0.00	10.03
USWNPLAINS	33.99	0.00	82.43	49.10	33.59	0.00	0.00	51.75	0.00	0.00	41.57

Note: Rate of 0 implies no reported movement.

Table 6.2.3. Rail Rates for Soybeans from U.S. Production Regions to U.S. Export and Barge Loading Regions, 2002 ($/MT).

ProdReg	DulSup	EastCo	Mexico	NOLA	PNW	TexasG	Toledo	Reach1	Reach2	Reach3	Reach4
USCPLAINS	0.00	0.00	34.00	20.69	31.58	17.67	0.00	9.02	0.00	0.00	0.00
USCPLAINSR	0.00	0.00	28.31	17.33	24.50	17.58	0.00	5.14	0.00	0.00	0.00
USDELTA	0.00	0.00	0.00	9.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USILNorth	0.00	0.00	0.00	12.25	27.76	0.00	0.00	6.64	0.00	0.00	7.47
USILSouth	0.00	0.00	0.00	11.26	0.00	0.00	0.00	5.17	0.00	0.00	0.00
USINNorth	0.00	21.97	0.00	0.00	0.00	0.00	0.00	5.43	0.00	0.00	52.84
USIowaR	0.00	0.00	0.00	13.43	0.00	0.00	0.00	7.02	0.00	0.00	7.02
USIowaW	0.00	0.00	27.52	21.38	0.00	0.00	0.00	12.71	5.21	0.00	9.12
USMI	0.00	17.04	0.00	108.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USMN	10.21	0.00	37.89	23.47	29.58	0.00	0.00	15.99	0.00	10.97	14.77
USMNR	0.00	0.00	0.00	21.97	27.82	0.00	0.00	11.20	7.69	11.10	10.87
USMOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.13	0.00	0.00	0.00
USMOW	0.00	0.00	23.24	15.53	31.37	27.10	0.00	6.71	5.52	0.00	0.00
USNE	0.00	32.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USNPLAINS	11.82	0.00	0.00	25.11	29.34	23.76	0.00	17.73	18.70	14.38	16.80
USOH	0.00	21.98	0.00	0.00	0.00	0.00	0.00	12.84	0.00	0.00	23.29
USPNW	0.00	0.00	0.00	0.00	37.86	0.00	0.00	0.00	0.00	0.00	0.00
USSE	0.00	4.28	0.00	12.68	34.67	0.00	0.00	0.00	0.00	0.00	0.00
USSPLAINS	0.00	0.00	7.95	27.01	0.00	12.53	0.00	0.00	0.00	0.00	0.00
USWiscS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.56	0.00	0.00	7.56

Note: Rate of 0 implies no reported movement.

Table 6.2.4. Estimated Rail Rates for Corn from U.S. Production Regions to U.S. Domestic Consumption Regions, 2002 ($/MT).

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	13.02	0.00	27.82	0.00	0.00	24.79	0.00	19.50	13.50	26.34
USCPLAINSR	14.46	14.97	0.00	0.00	0.00	27.39	0.00	23.24	0.00	29.95
USDELTA	0.00	7.17	0.00	0.00	0.00	0.00	0.00	17.03	0.00	0.00
USILNorth	0.00	16.62	4.02	17.27	0.00	0.00	19.43	16.70	6.87	75.88
USILSouth	0.00	14.11	3.28	28.88	0.00	0.00	17.56	15.09	21.12	0.00
USINNorth	0.00	0.00	4.34	15.93	0.00	0.00	19.52	0.00	0.00	0.00
USINRiver	0.00	0.00	0.00	0.00	0.00	0.00	18.80	0.00	0.00	0.00
USIowaR	0.00	0.00	7.84	0.00	0.00	0.00	12.09	15.03	4.01	0.00
USIowaW	19.48	21.03	13.04	0.00	0.00	26.81	24.46	23.12	11.80	31.21
USMI	0.00	0.00	5.66	19.07	0.00	0.00	24.58	0.00	0.00	0.00
USMN	17.46	23.90	12.01	0.00	24.23	29.02	24.43	24.58	11.18	32.93
USMNR	19.64	23.19	10.59	0.00	0.00	31.93	17.75	25.78	8.33	37.57
USMOR	0.00	0.00	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USMOW	12.24	14.44	5.69	23.32	0.00	29.78	20.46	14.85	6.34	42.96
USNE	0.00	0.00	0.00	10.29	0.00	0.00	14.40	0.00	0.00	0.00
USNPLAINS	10.99	28.45	13.26	0.00	20.56	32.40	27.04	21.90	15.89	30.44
USOH	0.00	0.00	3.04	15.39	0.00	0.00	20.66	0.00	0.00	0.00
USPNW	0.00	0.00	0.00	0.00	0.00	4.63	0.00	0.00	0.00	0.00
USSE	0.00	11.59	1.35	13.00	0.00	0.00	13.43	0.00	0.00	0.00
USSPLAINS	16.93	0.00	0.00	0.00	0.00	0.00	0.00	13.04	0.24	24.31
USWEST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.67	0.00	11.83
USWiscS	0.00	17.28	7.60	0.00	0.00	0.00	0.00	22.62	0.00	0.00
USWiscW	0.00	19.80	0.00	0.00	0.00	0.00	0.00	24.82	0.00	0.00

Note: Rate of 0 implies no reported movement.

Table 6.2.5. Estimated Rail Rates for Wheat from U.S. Production Regions to U.S. Domestic Consumption Regions, 2002 ($/MT).

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	15.48	0.00	18.58	8.10	0.00	23.12	22.64	22.35	17.40	25.96
USCPLAINSR	11.64	0.00	15.55	0.00	38.60	0.00	0.00	14.79	11.22	29.58
USDELTA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.63
USILNorth	13.89	0.00	11.21	18.81	0.00	0.00	22.10	0.00	12.78	21.37
USILSouth	5.39	0.00	8.88	29.43	0.00	0.00	26.89	0.00	0.00	0.00
USINNorth	0.00	0.00	10.44	10.01	0.00	0.00	17.03	0.00	17.24	0.00
USINRiver	0.00	0.00	6.82	0.00	0.00	0.00	15.83	0.00	0.00	0.00
USMI	20.48	0.00	10.26	16.87	0.00	0.00	18.48	0.00	0.00	0.00
USMN	0.00	0.00	18.30	44.21	8.40	0.00	44.45	33.85	16.44	0.00
USMNR	0.00	0.00	9.51	17.58	0.00	0.00	0.00	0.00	5.31	0.00
USMOR	0.00	0.00	0.00	0.00	0.00	0.00	52.61	0.00	0.00	0.00
USMOW	13.69	17.36	10.74	0.00	0.00	0.00	22.03	15.05	10.34	0.00
USNE	0.00	0.00	21.21	8.40	0.00	0.00	0.00	0.00	0.00	0.00
USNPLAINS	28.00	0.00	24.95	48.94	9.48	38.13	41.32	22.41	26.92	68.09
USOH	0.00	31.54	5.93	17.36	0.00	0.00	15.23	0.00	15.23	0.00
USPNW	17.30	0.00	0.00	0.00	0.00	10.15	0.00	0.00	25.96	24.46
USSE	0.00	0.00	0.00	13.29	0.00	0.00	14.07	0.00	0.00	0.00
USSPLAINS	22.92	0.00	31.98	0.00	0.00	0.00	15.05	18.07	0.00	26.15
USWEST	0.00	0.00	38.16	0.00	0.00	0.00	0.00	27.96	44.71	16.86
USWiscS	0.00	0.00	9.46	0.00	0.00	0.00	0.00	0.00	37.45	40.59
USWiscW	0.00	0.00	10.04	34.67	0.00	0.00	0.00	0.00	0.00	0.00
USWNPLAINS	0.00	0.00	38.01	0.00	11.91	26.78	0.00	0.00	64.36	38.40

Note: Rate of 0 implies no reported movement.

Table 6.2.6. Estimated Rail Rates for Soybeans from U.S. Production Regions to U.S. Domestic Consumption Regions, 2002 ($/MT).

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	9.40	25.62	0.00	0.00	0.00	25.70	17.90	21.77	9.02	29.23
USCPLAINSR	10.59	18.21	0.00	0.00	0.00	0.00	20.18	25.36	5.14	30.68
USDELTA	0.00	0.00	0.00	0.00	0.00	0.00	15.02	24.34	0.00	0.00
USILNorth	0.00	8.74	7.08	0.00	0.00	0.00	21.16	0.00	0.00	0.00
USILSouth	0.00	8.67	5.58	0.00	0.00	0.00	13.16	0.00	0.00	0.00
USINNorth	0.00	0.00	3.94	0.00	0.00	0.00	17.95	0.00	0.00	0.00
USINRiver	0.00	0.00	4.21	0.00	0.00	0.00	19.58	0.00	0.00	0.00
USIowaR	0.00	0.00	7.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USIowaW	0.00	17.79	12.74	0.00	0.00	0.00	19.50	31.74	7.01	32.29
USMI	0.00	0.00	5.64	0.00	0.00	0.00	22.00	0.00	0.00	0.00
USMN	13.59	0.00	11.70	0.00	0.00	0.00	24.03	29.44	10.65	0.00
USMNR	0.00	0.00	10.98	0.00	0.00	0.00	0.00	0.00	7.31	31.00
USMOR	0.00	0.00	4.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USMOW	10.66	15.27	6.92	0.00	0.00	0.00	18.17	19.66	6.29	0.00
USNE	0.00	0.00	0.00	11.21	0.00	0.00	21.71	0.00	0.00	0.00
USNPLAINS	17.36	0.00	14.04	0.00	2.05	0.00	24.68	24.85	12.60	0.00
USOH	0.00	0.00	3.95	16.28	0.00	0.00	13.61	0.00	0.00	0.00
USSE	0.00	4.80	1.35	0.00	0.00	0.00	12.05	0.00	0.00	0.00
USSPLAINS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.72	0.00	0.00
USWiscS	0.00	0.00	7.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Rate of 0 implies no reported movement.

Table 6.2.7. Estimated Rail Rate Relationships

	Domestic			Export & Barge		
	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat
Intercept	.88961	3.9615	6.80495	0.99119	4.55248	8.3922
Total Dist	.02229	.0168	0.01976	.02371	0.01622	
Total Dist2				-4.64E-06		0.0000346
Total Dist3	-5.10E-09					-2.45E-08
Total Dist4	1.89E-12				-3.89E-13	5.30E-12
Dist Barge	.00339	0.00557		.0027	0.00440	.004761
Spread PNW-Gulf	.30129			.23184		
R2	.83	.66	.38	.77	.65	.65

* All parameters significant at .05 level

Table 6.2.8 Forecast Rail Rates for Corn Shipment to Export and Barge Locations

ProdReg	DulSup	EastCo	Mexico	NOLA	TexasG	Toledo	PNW	Reach1	Reach2	Reach3	Reach4
USCPLAINS	19.33	29.30	35.06	27.81	43.03	23.94	28.05	13.50	18.17	17.26	19.01
USCPLAINSR	15.09	24.52	37.17	21.24	21.15	17.95	24.34	11.55	11.19	12.41	11.97
USDELTA	22.97	21.68	11.20	6.13	11.20	19.45	32.39	13.29	17.08	21.14	16.17
USILNorth	12.15	15.21	28.33	10.49	19.92	9.99	29.85	3.98	4.62	10.39	5.75
USILSouth	15.53	16.81	17.49	9.22	17.49	11.48	30.54	3.27	8.16	13.65	2.67
USINNorth	14.73	14.31	21.02	18.57	21.02	7.16	31.48	4.30	8.90	13.70	6.25
USINRiver	16.44	15.25	19.26	16.35	19.26	9.11	31.58	7.93	9.95	15.14	8.33
USIowaR	10.56	20.45	20.25	19.57	20.25	11.98	28.84	7.76	5.14	8.26	7.84
USIowaW	11.34	23.16	32.62	21.61	22.79	15.43	27.95	13.15	13.25	8.45	9.64
USMI	13.13	17.53	24.90	22.93	24.90	7.50	32.02	12.51	11.46	13.40	12.51
USMN	3.55	25.47	33.50	25.07	25.53	17.80	25.59	13.00	8.89	10.32	12.01
USMNR	7.94	23.08	43.05	25.86	23.32	14.72	26.47	11.29	8.00	7.34	10.98
USMOR	14.49	19.24	17.33	16.18	17.33	12.33	29.73	5.10	7.05	12.34	6.21
USMOW	15.78	20.76	35.25	18.51	16.25	14.52	35.39	5.81	8.99	13.45	8.57
USNE	22.25	13.36	29.03	26.26	29.03	14.33	34.71	21.31	20.73	22.74	20.07
USNPLAINS	13.26	27.96	39.49	26.07	25.02	21.25	25.03	19.20	15.89	14.66	17.24
USOH	16.67	18.22	22.41	19.30	22.41	3.10	32.14	12.16	12.30	16.21	11.13
USPNW	28.59	36.10	32.67	34.29	32.67	33.43	6.34	31.30	30.29	28.08	31.01
USSE	23.91	3.10	18.52	6.61	18.52	16.72	33.09	15.87	18.75	22.86	17.48
USSPLAINS	26.66	30.01	6.75	19.22	11.06	27.08	30.45	21.20	23.10	24.81	23.06
USWEST	31.24	36.46	29.87	32.78	29.87	34.28	20.95	31.25	31.11	30.22	31.59
USWiscS	8.77	20.48	23.63	22.55	23.63	11.03	30.02	7.59	8.29	8.42	7.41
USWiscW	6.10	21.98	23.99	23.36	23.99	13.07	28.88	13.48	9.33	6.16	10.64
USWNPLAINS	22.49	33.20	28.56	30.46	28.56	28.79	18.13	25.85	24.43	21.65	25.39

Table 6.2.9 Forecast Rail Rates for Wheat Shipment to Export and Barge Locations

ProdReg	DulSup	EastCo	Mexico	NOLA	TexasG	Toledo	PNW	Reach1	Reach2	Reach3	Reach4
USCPLAINS	56.35	32.83	27.08	22.92	22.33	26.87	35.38	17.98	20.96	26.21	19.26
USCPLAINSR	16.28	27.11	19.95	21.25	18.41	19.38	30.75	14.05	12.81	24.30	15.30
USDELTA	25.43	23.90	18.02	8.21	13.07	21.26	36.37	14.76	18.56	23.26	17.58
USILNorth	12.76	19.58	22.06	9.43	20.60	10.12	32.33	11.38	8.53	11.32	10.97
USILSouth	16.19	18.92	18.38	16.26	18.38	10.91	33.26	5.77	9.99	14.26	9.32
USINNorth	15.52	13.80	22.67	19.77	22.67	9.80	34.76	10.78	10.69	14.49	9.97
USINRiver	17.25	15.95	20.49	17.14	20.49	10.64	34.94	6.82	11.20	15.83	10.19
USIowaR	11.45	21.79	21.55	20.75	21.55	12.62	31.20	10.05	8.39	9.91	8.91
USIowaW	12.59	25.32	22.16	22.45	22.16	16.39	30.64	12.21	10.56	10.68	11.37
USMI	14.39	20.52	35.00	25.24	27.53	5.34	35.71	11.60	13.00	14.64	8.59
USMN	13.37	27.91	27.12	27.46	24.88	18.93	37.58	18.99	13.79	16.20	20.28
USMNR	8.85	24.91	25.18	25.02	25.18	15.25	29.67	9.29	10.77	6.25	9.51
USMOR	15.02	20.35	18.12	16.83	18.12	12.92	32.19	8.39	9.30	12.93	8.96
USMOW	16.61	22.34	17.12	23.33	18.36	15.29	32.30	10.51	10.72	14.24	10.47
USNE	24.79	11.66	32.45	29.46	32.45	19.73	46.75	42.00	22.98	25.38	48.50
USNPLAINS	21.84	30.92	27.71	33.53	31.91	23.28	47.45	28.70	17.14	26.40	25.70
USOH	17.38	15.18	24.12	11.75	24.12	4.68	36.50	13.57	12.90	16.86	13.07
USPNW	33.19	45.76	37.55	39.71	32.05	38.46	14.13	26.12	35.02	27.83	35.77
USSE	25.86	11.06	19.50	13.35	19.50	17.42	42.24	16.48	19.78	24.65	18.29
USSPLAINS	30.34	33.95	25.05	18.82	18.89	30.81	34.41	31.98	26.17	28.21	31.98
USWEST	36.30	46.17	34.85	37.93	26.81	39.78	26.31	38.66	36.16	35.22	40.23
USWiscS	10.86	22.14	28.17	24.61	25.88	12.36	32.86	10.96	10.60	10.67	8.08
USWiscW	9.38	23.80	26.15	30.20	26.15	13.88	31.46	10.03	10.92	9.40	10.03
USWNPLAINS	33.99	37.81	82.43	49.10	32.47	32.72	33.59	51.75	27.80	24.49	41.57

Table 6.2.10 Forecast Rail Rates for Soybean Shipment to Export and Barge Locations

ProdReg	DulSup	EastCo	Mexico	NOLA	TexasG	Toledo	PNW	Reach1	Reach2	Reach3	Reach4
USCPLAINS	18.71	28.94	34.00	20.69	17.67	23.17	31.58	9.02	17.66	16.86	18.42
USCPLAINSR	14.41	23.33	28.31	17.33	17.58	16.92	24.50	5.14	11.24	12.21	11.86
USDELTA	21.88	20.60	11.46	9.58	11.46	18.47	32.00	13.12	16.32	20.08	15.53
USILNorth	11.28	16.88	18.15	12.25	18.15	9.56	27.76	6.64	5.60	9.88	7.47
USILSouth	14.21	16.39	15.96	11.26	15.96	10.83	29.51	5.17	8.27	12.61	7.22
USINNorth	13.70	21.97	19.45	17.11	19.45	7.73	30.61	5.43	9.03	12.83	52.84
USINRiver	15.07	14.02	17.65	14.99	17.65	9.06	30.59	8.17	9.70	13.93	8.47
USIowaR	10.01	18.67	18.47	13.43	18.47	11.14	27.60	7.02	4.55	8.24	7.02
USIowaW	11.08	21.72	27.52	21.38	19.07	14.45	26.87	12.71	5.21	8.87	9.12
USMI	12.78	17.04	23.72	108.14	23.72	8.45	31.47	13.38	11.44	13.00	11.28
USMN	10.21	24.10	37.89	23.47	23.34	16.47	29.58	15.99	12.22	10.97	14.77
USMNR	6.50	21.32	21.56	21.97	21.56	13.42	27.82	11.20	7.69	11.10	10.87
USMOR	13.22	17.50	15.72	14.70	15.72	11.42	28.58	4.13	7.35	11.43	6.74
USMOW	14.59	19.18	23.24	15.53	27.10	13.51	31.37	6.71	5.52	12.61	8.76
USNE	21.40	32.29	28.56	25.52	28.56	14.27	33.17	20.49	19.93	21.89	19.31
USNPLAINS	11.82	27.08	23.89	25.11	23.76	20.06	29.34	17.73	18.70	14.38	16.80
USOH	15.13	21.98	20.62	17.56	20.62	4.55	30.88	12.84	11.40	14.72	23.29
USPNW	29.00	36.37	33.53	35.23	33.53	34.35	37.86	32.00	30.87	28.45	31.67
USSE	22.18	4.28	16.82	12.68	16.82	15.17	34.67	14.42	17.04	21.09	15.86
USSPLAINS	26.32	30.01	7.95	27.01	12.53	26.78	30.49	20.82	22.66	24.39	22.62
USWEST	32.13	37.02	30.62	33.86	30.62	35.48	21.63	32.14	31.99	30.99	32.53
USWiscS	9.11	19.06	22.21	21.11	22.21	10.84	29.19	7.56	8.75	8.85	7.56
USWiscW	6.94	20.39	22.45	21.80	22.45	12.29	27.80	12.62	9.33	6.99	10.34
USWNPLAINS	22.10	33.51	28.42	30.55	28.42	28.68	18.07	25.50	24.04	21.30	25.03

Table 6.2.11. Forecast Rail Rates for Corn Shipment to Domestic Locations.

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	13.02	21.91	27.82	30.97	14.44	24.79	27.53	19.50	13.50	26.34
USCPLAINSR	14.46	14.97	17.45	25.49	17.44	27.39	21.96	23.24	10.56	29.95
USDELTA	20.54	7.17	19.69	25.70	26.41	33.26	15.02	17.03	19.19	29.40
USILNorth	17.30	16.62	4.02	17.27	20.82	29.16	19.43	16.70	6.87	75.88
USILSouth	17.64	14.11	3.28	28.88	22.29	30.21	17.56	15.09	21.12	28.49
USINNorth	20.58	16.68	4.34	15.93	23.82	32.01	19.52	23.63	12.20	31.08
USINRiver	20.43	14.37	9.01	17.30	24.31	32.39	18.80	22.41	13.23	30.78
USIowaR	15.49	16.80	7.84	20.30	18.87	27.59	12.09	15.03	4.01	27.08
USIowaW	19.48	21.03	13.04	23.26	17.08	26.81	24.46	23.12	11.80	31.21
USMI	22.87	21.41	5.66	19.07	24.64	32.92	24.58	27.02	13.91	33.20
USMN	17.46	23.90	12.01	24.26	24.23	29.02	24.43	24.58	11.18	32.93
USMNR	19.64	23.19	10.59	21.70	16.33	31.93	17.75	25.78	8.33	37.57
USMOR	16.02	13.06	5.10	20.56	20.86	28.92	16.32	19.22	9.51	27.33
USMOW	12.24	14.44	5.69	23.32	20.79	29.78	20.46	14.85	6.34	42.96
USNE	30.04	26.15	16.28	10.29	31.85	43.24	14.40	32.84	23.15	43.50
USNPLAINS	10.99	28.45	13.26	27.71	20.56	32.40	27.04	21.90	15.89	30.44
USOH	22.84	18.05	3.04	15.39	25.64	34.24	20.66	25.30	15.05	33.30
USPNW	25.38	35.91	36.08	45.44	20.45	4.63	42.80	31.09	30.61	20.14
USSE	24.77	11.59	1.35	13.00	29.18	38.74	13.43	23.36	20.59	34.44
USSPLAINS	16.93	18.46	27.38	33.68	25.23	29.73	26.07	13.04	0.24	24.31
USWEST	23.49	32.54	36.16	46.18	23.80	20.63	39.00	42.67	30.87	11.83
USWiscS	19.01	17.28	7.60	19.02	20.65	29.23	21.26	22.62	9.05	29.65
USWiscW	17.88	19.80	12.43	20.35	18.73	27.65	22.57	24.82	8.59	28.48
USWNPLAINS	17.35	29.35	28.83	35.28	10.28	15.89	33.96	25.94	23.05	19.90

Table 6.2.11. Forecast Rail Rates for Wheat Shipment to Domestic Locations.

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	15.48	22.92	18.58	8.10	14.85	23.12	22.64	22.35	17.40	25.96
USCPLAINSR	11.64	18.02	15.55	28.91	38.60	29.98	24.14	14.79	11.22	29.58
USDELTA	22.01	6.80	21.02	28.76	29.80	39.85	16.03	18.24	20.45	26.63
USILNorth	13.89	18.44	11.21	18.81	24.09	36.05	22.10	25.10	12.78	21.37
USILSouth	5.39	14.97	8.88	29.43	25.80	37.37	26.89	22.90	13.44	34.82
USINNorth	23.26	18.77	10.44	10.01	27.50	39.49	17.03	27.24	17.24	38.21
USINRiver	23.29	16.55	6.82	19.64	28.45	40.24	15.83	25.83	15.41	38.05
USIowaR	17.96	19.36	13.47	23.44	21.71	33.68	22.18	24.43	8.48	32.91
USIowaW	15.10	19.92	16.45	26.38	18.93	30.80	24.29	22.85	8.65	29.99
USMI	20.48	23.46	10.26	16.87	27.72	39.83	18.48	31.18	15.25	40.20
USMN	17.53	26.07	18.30	44.21	8.40	28.29	44.45	33.85	16.44	30.56
USMNR	18.17	24.00	9.51	17.58	18.85	30.94	26.89	27.25	5.31	32.25
USMOR	18.52	15.48	14.02	23.76	24.13	35.69	52.61	22.13	12.09	33.29
USMOW	13.69	17.36	10.74	25.59	23.53	34.77	22.03	15.05	10.34	31.78
USNE	34.57	28.76	21.21	8.40	37.26	49.35	22.78	38.66	24.67	49.54
USNPLAINS	28.00	26.94	24.95	48.94	9.48	38.13	41.32	22.41	26.92	68.09
USOH	26.74	31.54	5.93	17.36	30.75	42.80	15.23	30.24	15.23	41.69
USPNW	17.30	39.85	40.08	49.35	18.92	10.15	47.26	32.83	25.96	24.46
USSE	29.46	16.03	19.37	13.29	36.07	47.26	14.07	27.46	23.80	43.04
USSPLAINS	22.92	18.24	31.98	38.66	26.31	32.83	15.05	18.07	24.43	26.15
USWEST	21.78	34.29	38.16	49.54	22.15	18.58	43.04	27.96	44.71	16.86
USWiscS	21.06	22.72	9.46	21.08	23.01	35.12	23.77	28.35	37.45	40.59
USWiscW	20.12	24.01	10.04	34.67	21.09	33.16	25.83	28.48	10.88	34.43
USWNPLAINS	17.00	32.13	38.01	40.69	11.91	26.78	38.94	27.18	64.36	38.40

Table 6.2.13. Forecast Rail Rates for Soybean Shipment to Domestic Locations.

ProdReg	CPlains	Delta	ECornB	NEast	NPlains	PNW	SEast	SPlains	WCornB	West
USCPLAINS	9.40	25.62	23.36	31.87	14.13	25.70	17.90	21.77	9.02	29.23
USCPLAINSR	10.59	18.21	16.03	24.56	16.02	25.48	20.18	25.36	5.14	30.68
USDELTA	19.21	6.28	18.36	24.94	25.83	34.37	15.02	24.34	17.88	29.64
USILNorth	15.11	8.74	7.08	16.47	18.66	28.82	21.16	19.51	7.41	27.85
USILSouth	15.53	8.67	5.58	17.67	20.35	30.19	13.16	17.89	9.84	28.02
USINNorth	18.65	14.84	3.94	14.59	22.26	32.45	17.95	22.04	10.97	31.36
USINRiver	18.38	12.64	4.21	15.28	22.76	32.79	19.58	20.54	11.68	30.93
USIowaR	13.44	14.64	7.02	18.10	16.63	26.81	17.03	18.94	5.39	26.15
USIowaW	12.13	17.79	12.74	21.72	15.39	25.48	19.50	31.74	7.01	32.29
USMI	21.49	19.90	5.64	13.88	23.53	33.82	22.00	26.46	12.92	34.13
USMN	13.59	21.25	11.70	22.84	12.97	23.14	24.03	29.44	10.65	25.07
USMNR	13.63	18.58	10.98	19.61	14.20	24.48	21.04	21.34	7.31	31.00
USMOR	13.92	11.34	4.13	18.37	18.69	28.52	14.20	16.99	8.46	26.48
USMOW	10.66	15.27	6.92	20.60	18.85	28.41	18.17	19.66	6.29	25.86
USNE	30.64	25.70	15.56	11.21	32.92	43.20	21.71	34.12	22.22	43.36
USNPLAINS	17.36	22.99	14.04	27.37	2.05	20.55	24.68	24.85	12.60	22.55
USOH	20.91	15.83	3.95	16.28	24.32	34.57	13.61	23.88	13.05	33.62
USPNW	25.87	38.73	38.92	46.80	20.93	10.63	45.03	32.76	32.15	20.64
USSE	23.22	4.80	1.35	17.54	28.84	38.36	12.05	21.52	18.41	34.77
USSPLAINS	18.11	18.12	27.54	35.49	24.98	30.53	25.96	20.72	23.39	23.41
USWEST	24.18	34.81	39.26	47.77	24.49	21.46	42.25	26.45	32.65	11.44
USWiscS	17.22	18.63	7.56	17.23	18.88	29.17	19.52	23.42	8.69	29.70
USWiscW	15.94	19.25	11.14	18.39	16.76	27.03	20.80	23.05	8.08	28.10
USWNPLAINS	17.20	30.07	29.40	37.34	11.46	15.95	35.85	25.85	22.63	19.51

6.3 US truck Shipping rates for truck shipments will be estimated from rate functions which are a function of distance. Distance matrixes were created from centroids of production regions to export and barge loading regions and to centroids of domestic consumption regions Tables 6.3.1-6.3.2. These distance matrixes will be used to estimate truck shipping costs.

Rate functions were derived from USDA-AMS data on trucking costs from 4th quarter 2003 to 3rd quarter 2004. Data were for specific milage distances (25, 100 and 200 miles). Logrithmic relations were estimated between rates/mile and distance. Results indicated:

$$Truck\cos t\ /\ Mile = 4.12 \cdot -.472 \cdot LN(Miles)$$

R-square for relationship was .90. Relationships between distance and rate per loaded mile and per MT are shown in figures 6.3.1 and 6.3.2.

This relationship was used along with distance matrixes to derive an estimate of the truck rate from each origin to each destination. In the model, a limit was placed at 350 miles at which point truck rates were set to arbitrarily high values to preclude their choice as shipment option.

Table 6.3.1. Estimated Miles between Centroids of Production and Consumption Regions.

ProdReg	USCPLAINS	USDELTA	USECB	USNE	USNPLAINS	USPNW	USSE	USSPLAINS	USWCB	USWEST
USCPLAINS	59	815	956	1463	407	858	1201	582	567	700
USCPLAINSR	297	568	611	1119	610	1173	877	635	265	1051
USDELTA	770	0	719	1111	1164	1672	467	579	691	1391
USILNorth	664	589	237	745	875	1480	671	926	205	1422
USILSouth	674	413	330	802	961	1547	529	815	336	1418
USINNorth	833	605	114	591	1048	1654	558	1034	375	1589
USINRiver	834	493	233	650	1095	1692	445	963	435	1581
USIowaR	564	635	337	842	754	1360	778	892	85	1321
USIowaW	420	664	488	991	613	1214	885	812	93	1173
USMI	937	843	131	484	1058	1671	761	1233	427	1690
USMN	543	975	632	1069	482	1087	1158	1062	301	1202
USMNR	575	870	482	932	610	1222	1016	1035	180	1288
USMOR	593	439	365	858	877	1462	609	775	268	1340
USMOW	527	388	460	951	847	1415	636	681	303	1264
USNE	1405	1111	508	0	1541	2153	808	1612	904	2162
USNPLAINS	411	1019	819	1280	263	874	1278	980	432	993
USOH	1009	707	150	427	1212	1822	529	1186	541	1766
USPNW	907	1672	1684	2153	613	0	2048	1317	1281	596
USSE	1146	467	636	808	1481	2048	0	1045	860	1834
USSPLAINS	578	579	1139	1612	987	1317	1045	0	892	893
USWEST	758	1391	1656	2162	777	596	1834	893	1263	0
USWiscS	722	805	273	722	820	1433	859	1091	214	1465
USWiscW	674	871	388	820	723	1334	963	1097	206	1398
USWNPLAINS	516	1282	1242	1715	174	442	1626	1031	839	653

Table 6.3.2. Estimated Miles between Centroids of Production Regions and Export and Barge Loading Locations.

ProdReg	Ecoast	Dul/Sup	TxGulf	NOLA	Toledo	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach6
USCPLAINS	1446	717	827	1003	1010	1068	679	650	599	698	857	975
USCPLAINSR	1106	522	709	777	680	1376	342	325	385	363	521	634
USDELTA	892	977	313	201	753	1879	416	616	857	567	423	587
USILNorth	769	415	851	766	309	1681	175	65	329	24	264	296
USILSouth	725	586	697	590	376	1755	43	218	486	153	137	267
USINNorth	591	531	900	747	162	1859	247	242	477	179	190	126
USINRiver	567	633	798	628	258	1897	204	298	561	222	72	109
USIowaR	885	337	872	829	407	1565	239	53	228	128	371	414
USIowaW	1031	348	854	869	558	1419	324	201	212	266	488	557
USMI	656	421	1135	993	153	1861	458	338	435	328	436	320
USMN	1213	225	1157	1181	696	1284	613	429	164	505	751	767
USMNR	1064	120	1081	1071	549	1418	487	292	21	366	612	620
USMOR	809	537	694	629	424	1666	49	173	425	135	225	342
USMOW	884	589	615	589	521	1619	120	247	465	227	290	428
USNE	401	905	1432	1192	451	2362	845	809	938	769	720	551
USNPLAINS	1384	397	1140	1222	877	1082	709	562	344	636	871	920
USOH	420	657	1016	813	113	2036	416	423	631	365	292	112
USPNW	2219	1239	1632	1845	1725	231	1484	1386	1198	1454	1661	1745
USSE	480	1125	764	448	659	2301	612	779	1049	703	456	492
USSPLAINS	1463	1171	368	680	1205	1507	797	917	1034	915	912	1080
USWEST	2207	1439	1314	1599	1787	694	1439	1426	1344	1473	1612	1743
USWiscS	851	226	1064	988	333	1636	397	204	210	247	465	428
USWiscW	965	115	1108	1062	446	1535	467	263	118	325	561	540
USWNPLAINS	1835	873	1322	1502	1343	614	1105	1003	821	1071	1281	1362

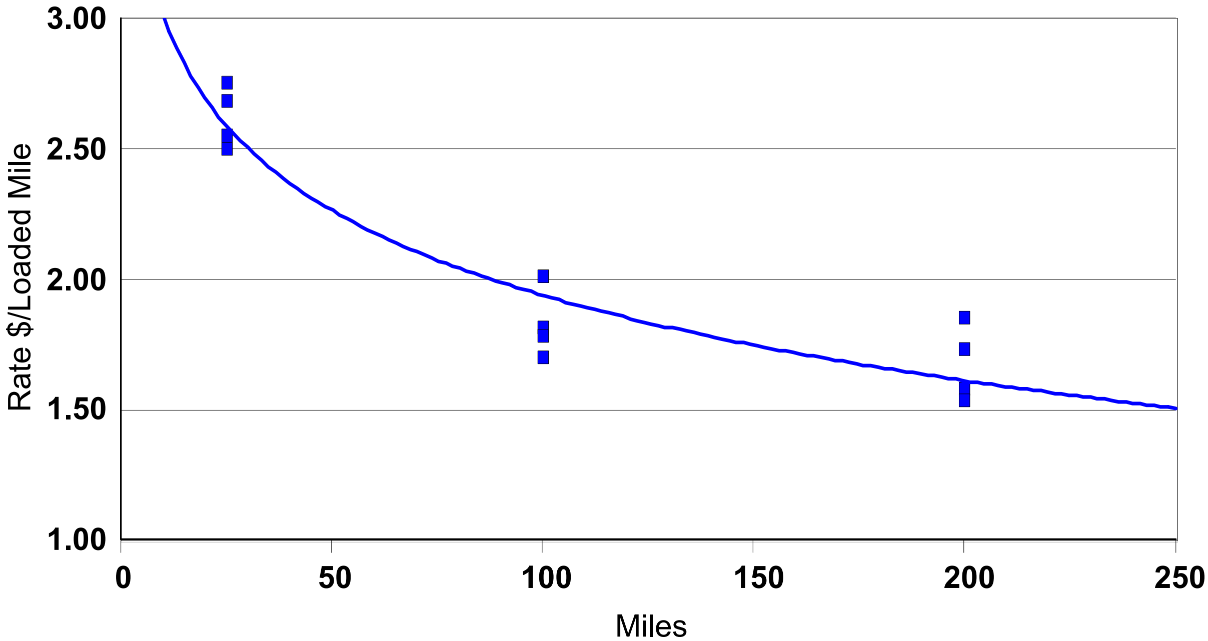


Figure 6.3.1. Estimated Relationship Between Distance of Shipment and Rate per Loaded Mile (Q4-2003 to Q3-2004).

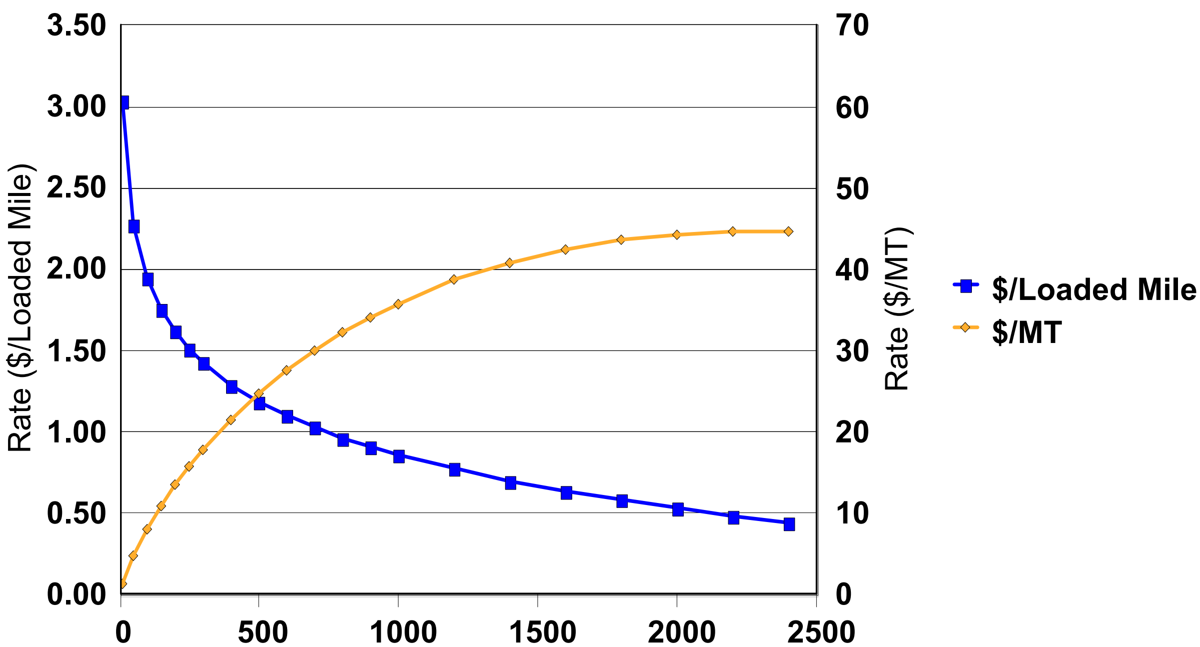


Figure 6.3.2. Estimated Relationship Between Distance, Rate Per Loaded Mile and Cost/MT.

6.4 US Barge Barge rates from each origin were derived from data (percent of tariff) as reported by AMS. The values were annual means and standard deviations for the 6 reaches and converted these to $/MT rates assuming draft adjustments.

Draft adjustments were made for the following locations where the draft adjustment was applied to % of tariff before converting to a $/MT measure. (i.e., for St. Louis in 2002 the % tariff was 128.38 and the draft adjustment was 15%. The rate is (128.38 - 15)/100 * Tariff rate in $/MT). Draft Adjustments were 0% of Illinois River and Cincinnati, 5% lower for Mpls, McGregor and Louisville and 15% for St. Louis.

Results are shown in Tables 6.4.1-6.4.2 and in Figures 6.4.1-6.4.2.

Table 6.4.1. Average Percent of Tariff and Standard Deviation by Barge Loading Area, 1990-2003.

Year	Mpls	McGregor	Peoria	St Louis	Cincinnati	Louisville
Average Annual % of Tariff						
1990	158.10	137.39	138.13	121.17	122.30	119.31
1991	176.56	151.95	146.98	130.69	141.88	136.04
1992	159.91	147.70	138.21	122.74	130.58	129.23
1993	172.59	147.72	140.45	116.76	125.86	122.25
1994	173.82	157.48	148.97	132.06	140.98	139.92
1995	297.18	255.03	243.75	205.96	209.69	210.42
1996	182.62	159.78	168.96	133.18	140.08	140.06
1997	179.00	151.62	142.65	117.37	130.36	128.92
1998	221.69	194.06	166.66	144.82	145.94	148.62
1999	234.11	198.13	184.02	147.54	146.79	150.04
2000	209.97	183.00	180.15	152.67	161.25	160.90
2001	218.42	191.41	185.13	154.71	161.13	163.09
2002	189.69	169.49	155.90	128.38	125.85	127.44
2003	216.00	193.84	189.00	159.00	162.00	162.00
Standard Deviation						
1990	27.43	21.22	29.85	22.73	19.09	19.03
1991	53.53	47.18	44.37	45.17	48.23	44.98
1992	32.79	38.62	36.74	42.39	45.73	48.38
1993	29.66	38.49	42.73	38.42	40.29	40.32
1994	58.61	65.36	63.90	62.29	64.86	65.65
1995	67.54	57.98	48.86	51.23	57.80	58.10
1996	38.62	41.77	61.75	42.68	42.72	42.50
1997	44.10	42.87	45.16	37.68	44.70	43.34
1998	69.31	69.21	65.99	74.25	66.43	67.85
1999	53.74	52.23	47.41	50.15	50.05	52.58
2000	40.25	47.86	47.59	49.10	51.46	51.20
2001	15.61	21.53	30.00	33.40	36.84	37.40
2002	39.36	43.68	34.29	33.09	27.34	27.40
2003	39.73	52.62	52.82	61.91	56.14	56.42

Table 6.4.2. Estimated Barge Rates ($/MT) and Standard Deviations Adjusted for Draft Differences, 1990-2003.

Year	Mpls	McGregor	Peoria	St Louis	Cincinnati	Louisville
Average Barge Rates ($/MT)						
1990	10.45	7.76	7.32	4.67	6.32	5.09
1991	11.71	8.62	7.79	5.09	7.34	5.84
1992	10.57	8.37	7.33	4.74	6.75	5.53
1993	11.44	8.37	7.45	4.48	6.51	5.22
1994	11.52	8.94	7.90	5.15	7.29	6.01
1995	19.94	14.66	12.92	8.40	10.84	9.15
1996	12.12	9.08	8.96	5.20	7.24	6.01
1997	11.87	8.60	7.56	4.50	6.74	5.52
1998	14.79	11.09	8.84	5.71	7.54	6.40
1999	15.63	11.33	9.76	5.83	7.59	6.46
2000	13.99	10.44	9.55	6.06	8.34	6.94
2001	14.56	10.93	9.82	6.14	8.33	7.04
2002	12.60	9.65	8.27	4.99	6.51	5.45
2003	14.40	11.07	10.02	6.33	8.38	6.99
Standard Deviation of Barge Rates ($/MT)						
1990	1.53	0.95	1.58	0.34	0.99	0.62
1991	3.31	2.47	2.35	1.33	2.49	1.78
1992	1.90	1.97	1.95	1.20	2.36	1.93
1993	1.68	1.96	2.27	1.03	2.08	1.57
1994	3.66	3.54	3.39	2.08	3.35	2.70
1995	4.27	3.11	2.59	1.59	2.99	2.36
1996	2.29	2.16	3.27	1.22	2.21	1.67
1997	2.67	2.22	2.39	1.00	2.31	1.71
1998	4.39	3.77	3.50	2.61	3.43	2.80
1999	3.33	2.77	2.51	1.55	2.59	2.12
2000	2.41	2.51	2.52	1.50	2.66	2.06
2001	0.72	0.97	1.59	0.81	1.90	1.44
2002	2.34	2.27	1.82	0.80	1.41	1.00
2003	2.37	2.79	2.80	2.06	2.90	2.29

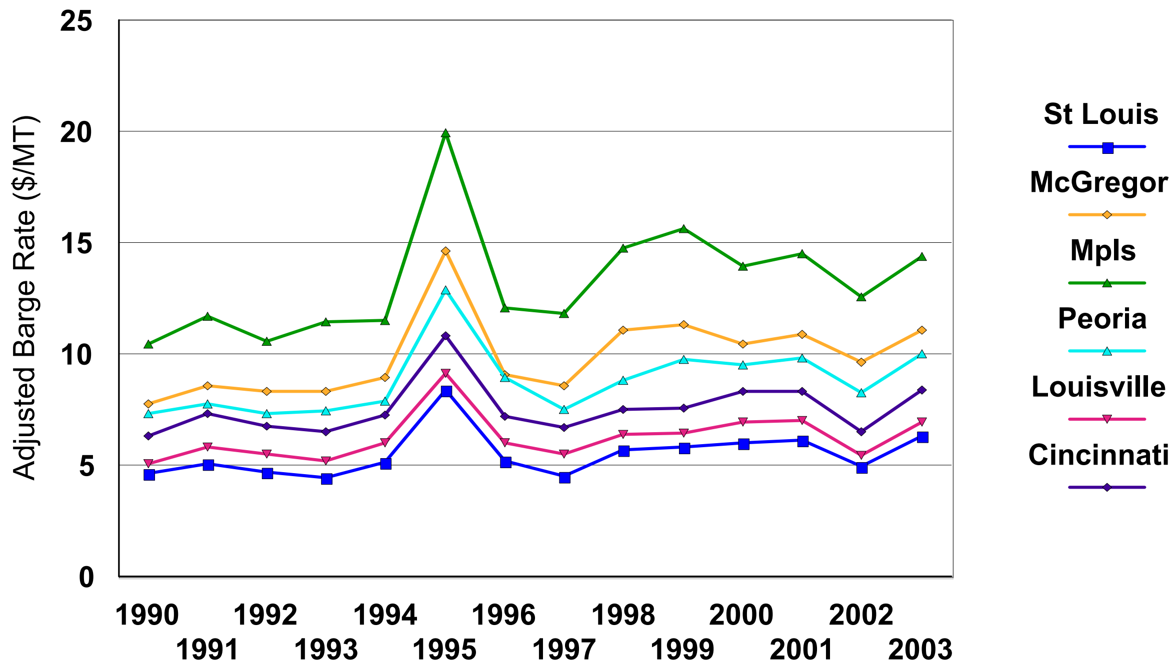


Figure 6.4.1. Draft Adjusted Average Barge Rates for the Six Reaches, 1990-2003 ($/MT).

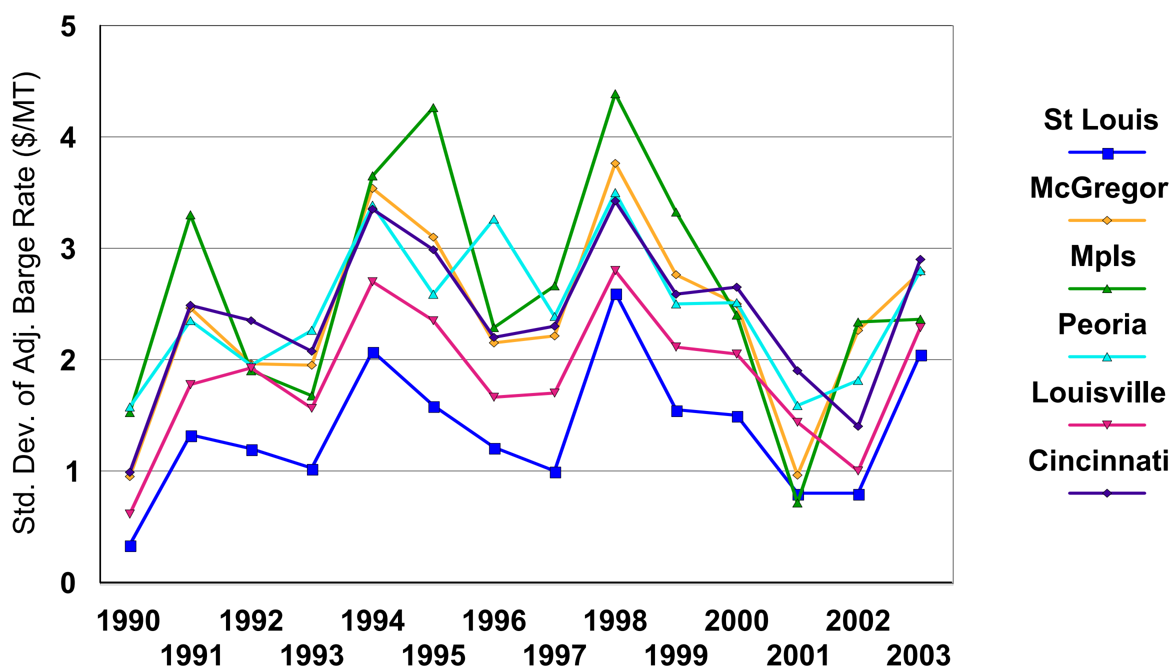


Figure 6.4.2. Standard Deviation of Draft Adjusted Barge Rates for Six Reaches, 1990-2003 ($/MT).

6.5 Handling rates For each of the major grain producing countries, handling fees were included. These are shown in Table 6.6.1.

Table 6.6.1. Barge transfer costs

Function	*c/b*	*$/t*	*Conversion*	*$/mt*
Transfer	3	1.05	35.00	1.10
Direct	4	1.43	35.75	1.47
Rough	5	1.45	29.00	1.84

In addition to these, a special set of handling fees were derive for shipments through the Great Lakes (Table 6.6.2).

Table 6.6.2. Handling Fees on the Great Lakes

Element/function	*Units*	*US via* Duluth	*US via* Toledo	*Canada via* T. Bay
	c/b	$/t	$/t	C$/mt
Port Elevation 1	2000 lb	2.75	2.25	8.17
Laker rates to St. Law	2000 lb	8.75	5	15
Locakage (incl other)	2000 lb	3	3	3
Transfer elevator	2000 lb	2.75	2.75	2.59
Total: Fob Ship St. Lawrence		17.25	13	28.76
		$/mt	*$/mt*	*$/mt*
Country elevation				
Port Elevation 1		3.03	2.48	5.20
Laker rates to St. Law		9.65	5.51	9.55
Locakage (incl other)		3.31	3.31	3.31
Transfer Elevator		3.03	3.03	1.65
Total: Fob Ship St. Lawrence		19.01	14.33	19.71

Finally, for each of the major competing exporting countries, a set of shipping and handling costs were included. These were obtained from industry sources in each of Argentina, Australia, India and the EU. Those for Canada and Brazil were modeled explicitly as described below.

6.6. Important Changes in Rail Rates There has been some fundamentally important changes in rail rates over the time period contained in this study. Rail rates from selected origins to Reach 1 and/or US Gulf have declined, relative to alternatives. These changes have important impacts on the results are described in Section 7. Their impact along with other costs are evaluated in Section 9.

Tables 6.6.1-6.6.3 show a summary of some of these changes to competing reaches. The rates shown are weighted averages. Volumes could not be shown. Some of the important points are:

» For soybeans (Table 6.6.1), there have been notable declines in rail shipping costs to Reach 1 from Iowa West, Minnesota, and the Northern Plains, and it appears there were increases going to Reach 3. For shipments going from Minnesota River there were not detectable rates prior to 1999, then they appeared to decline going to Reach 1 and concurrent increases going to Reach 3.

» For corn, this phenomena is apparent for Minnesota to Reach 1 vs Reach 3 (Table 6.6.2)

A similar comparison can be made for grain shipments to the PNW. A summary of these rates over time are shown in Table 6.6.3 for each grain. Results illustrate:

» Reduced rates on wheat from Minnesota and corresponding increase in movements;

» Reduced rates on corn from Minnesota and Northern plains, and substantial increases in shipments.

» Reduced rates on soybeans from Minnesota and Northern plains, and corresponding increases in rail shipments.

Combining these rates with barge rates and related differentials determines whether the grain is shipped by barge, or rail to barge at Reach 1. For perspective, in our analysis the 2002 barge rates to US Gulf from each reach are: Reach 1 $ 4.99/mt, Reach 2 $ 12.98/mt, Reach 3 $16.66/mt and from Reach 4 $10.43/mt. Thus, the difference between, as example Reach 4 and Reach 1 is $5.44 so rail rate differentials less than this would encourage a rail movement to Reach 1, by-passing the upper portions of the River system.

To illustrate these, the rail rate differentials for soybeans and corn were used, along with the 2002 barge rates (above) and ignoring transfer costs, to derive the cost of shipping to the US Gulf by rail to Reach 3 (or 4), and then barge to US Gulf; or rail to Reach 1 and then barge to US Gulf. Results are shown in Tables 6.6.4-6.6.6.

The results summarize the costs where relevant of shipping to Reaches 3 and 4 vs to Reach 1 and then barging to the US Gulf. Results for soybeans indicate there are cost advantages of going from Minnesota, Minnesota River and Northern Plains to Reach 1 vs to

Reach 3. Generally, these have increased from about the late 1990's through 2002. For Reach 4, the values have also increased since about 1998 or 1999 and in all cases in 2002 there was a cost advantage of shipping by rail to Reach 1 and then barge. That advantage is greatest in Illinois North, Minnesota, Minnesota River and the northern plains. For Iowa West that value is within the bounds of the handling differentials.

For corn shipments, whether grain goes to Reach 3 by rail and barged to the US Gulf, or by rail to Reach 1 is critical. Results show that there are substantial advantages of rail shipments from the origins in the Northern Plains, Minnesota and Minnesota River to Reach 1 and then by barge to the US Gulf. The advantages have generally been increasing during the last three years of the study period.

For shipments from Illinois North (Table 6.6.6), the rail rates to Reach 1 have declined from the \$8-11/mt range in the mid-1990s' to 3.98 in 2002, and the rate to Reach 4 (Illinois river) increased in 2002. In fact, in 2002, the rate to Reach 1 was less than the rate to Reach 4. The cost advantage of going to Reach 1 and then transshipped by barge has been increasing since the mid-1990s to 2002 in which that advantage is in the area of \$7/mt. Similar observations are apparent in soybeans from Illinois North (Table 6.6.1) to Reach 1 vs Reach 4; Minnesota to Reach 1 versus Reach 3; and Northern Plains going to Reach 1 vs Reach 4. In each case above there were notable increases in rail shipments to Reach 1.

Table 6.6.1. Soybeans: Comparison of Rail Shipments and Weighted Average Rail Rates from Selected Production Areas to Barge Loading Regions (Reaches), 1995 to 2002.

	Reach 1	Reach 2	Reach 3	Reach 4
	Weighted Average Rail Rate ($/MT)			
Illinois North				
1995	5.75	3.21	0.00	11.02
1996	5.67	0.00	0.00	6.92
1997	7.73	0.00	0.00	3.04
1998	7.73	0.00	0.00	3.25
1999	7.50	0.00	0.00	1.86
2000	5.81	4.02	0.00	1.96
2001	5.53	0.00	0.00	3.06
2002	6.64	0.00	0.00	7.47
Iowa River				
1995	0.00	2.10	0.00	0.00
1996	0.00	5.93	0.00	8.19
1997	0.00	6.92	0.00	0.00
1998	12.66	5.71	0.00	9.87
1999	0.00	5.89	0.00	0.00
2000	5.91	4.50	0.00	0.00
2001	8.26	0.00	0.00	8.01
2002	7.02	0.00	0.00	7.02
Iowa West				
1995	15.15	9.69	0.00	11.18
1996	13.91	10.76	0.00	11.62
1997	14.80	10.48	0.00	14.02
1998	14.44	10.33	0.00	10.90
1999	16.06	10.02	0.00	12.55
2000	11.21	6.80	0.00	10.27
2001	11.76	6.63	0.00	9.45
2002	12.71	5.21	0.00	9.12
Minnesota				
1995	16.39	0.00	8.37	16.90
1996	22.89	10.08	12.32	12.81
1997	20.96	11.93	8.93	16.51
1998	22.76	18.81	10.79	15.80
1999	19.61	15.43	10.90	11.08
2000	12.67	15.22	9.47	12.40
2001	14.20	0.00	9.88	13.42
2002	15.99	0.00	10.97	14.77
Minnesota River				
1995	0.00	10.95	6.20	10.69
1996	0.00	11.87	6.10	9.45
1997	0.00	11.66	4.78	10.56
1998	0.00	9.16	5.89	9.93
1999	18.65	9.49	5.00	10.41
2000	10.09	8.88	4.93	9.64
2001	11.17	7.56	5.67	9.85
2002	11.20	7.69	11.10	10.87
Northern Plains				
1995	16.42	0.00	10.69	0.00
1996	23.28	18.84	19.76	14.12
1997	21.37	21.44	10.56	21.63
1998	22.83	17.89	11.78	17.14
1999	21.28	20.08	10.51	15.04
2000	17.71	17.11	13.20	17.17
2001	17.56	18.64	16.16	18.42
2002	17.73	18.70	14.38	16.80

*A rate of 0.00 indicates the rate could not be detected from the Waybill data set.

Table 6.6.2. Corn: Comparison of Rail Shipments and Weighted Average Rail Rates from Selected Production Areas to Barge Loading Regions (Reaches), 1995 to 2002.

	Reach1	Reach2	Reach3	Reach4
	Weighted Average Rail Rate ($/MT)			
Northern Plains				
1995	0.00	0.00	9.48	0.00
1996	0.00	11.30	13.28	0.00
1997	17.76	0.00	12.74	16.65
1998	0.00	17.86	9.33	19.21
1999	0.00	13.78	11.64	17.63
2000	19.93	0.00	13.71	21.86
2001	18.21	0.00	14.46	16.79
2002	19.20	0.00	14.66	0.00
Minnesota				
1995	0.00	9.57	8.36	11.88
1996	17.92	11.66	10.39	13.49
1997	18.15	12.23	8.72	14.85
1998	13.62	11.24	8.48	14.62
1999	0.00	10.47	8.19	14.79
2000	14.23	9.28	9.96	14.19
2001	13.89	10.86	9.78	12.47
2002	13.00	8.89	10.32	12.01
Minnesota River				
1995	0.00	9.60	6.24	12.70
1996	0.00	11.08	8.14	13.37
1997	0.00	15.42	7.37	12.85
1998	0.00	10.60	5.99	12.74
1999	0.00	10.81	5.65	12.52
2000	12.59	9.27	5.04	12.85
2001	11.62	9.03	6.75	12.31
2002	11.29	8.00	7.34	10.98

*A rate of 0.00 indicates the rate could not be detected from the Waybill data set.

Table 6.6.3. PNW: Weighted Average Rail Shipping Rates ($/MT) for Selected Production Regions to PNW, by Crop, 1995-2002.

Corn

	CPLAINS	CPLAINSR	ILNorth	IowaW	MN	MNR	MOW	NPLAINS	PNW	WEST
1995	28.51	29.26	48.12	31.03	31.68	28.12	0.00	31.71	7.59	0.00
1996	26.53	26.49	48.55	28.10	30.46	27.88	28.07	32.16	8.55	24.48
1997	26.65	28.70	0.00	26.59	31.26	31.79	0.00	31.61	8.60	0.00
1998	25.62	27.28	0.00	29.41	28.69	31.71	0.00	29.48	6.22	0.00
1999	25.05	25.18	0.00	28.24	27.98	27.67	0.00	27.43	0.00	0.00
2000	25.67	26.67	0.00	32.23	27.12	32.56	0.00	27.81	4.08	0.00
2001	27.95	27.86	0.00	23.63	25.32	26.77	36.32	25.57	0.00	0.00
2002	28.05	24.34	0.00	0.00	25.59	26.47	35.39	25.03	0.00	0.00

Wheat

	CPLAINS	ILNorth	MN	NPLAINS	PNW	SPLAINS	WEST	WiscW	WNPLAINS
1995	31.89	0.00	53.27	50.52	17.91	39.93	27.44	0.00	33.22
1996	32.09	56.53	44.19	51.63	16.45	35.45	28.46	46.61	34.85
1997	35.85	0.00	0.00	43.91	22.36	42.74	26.43	0.00	35.96
1998	35.15	0.00	47.02	44.08	18.46	0.00	18.98	0.00	36.79
1999	29.05	0.00	0.00	40.51	16.96	0.00	25.00	0.00	37.58
2000	29.31	0.00	0.00	39.42	16.02	0.00	0.00	0.00	36.01
2001	33.25	0.00	31.22	43.82	14.94	0.00	24.59	0.00	34.48
2002	35.38	0.00	37.58	47.45	14.13	0.00	26.31	0.00	33.59

Soybeans

	CPLAINS	CPLAINSR	ILNorth	IowaW	MI	MN	MNR	MOW	NPLAINS	PNW	SE
1995	27.10	33.11	0.00	27.09	0.00	28.78	27.00	0.00	29.44	0.00	0.00
1996	28.98	25.29	0.00	0.00	0.00	29.29	29.79	0.00	31.75	8.25	0.00
1997	35.04	29.58	22.62	30.30	0.00	31.67	0.00	0.00	32.98	6.05	0.00
1998	26.93	24.55	0.00	31.09	0.00	31.62	0.00	0.00	32.99	6.11	0.00
1999	25.36	0.00	0.00	0.00	0.00	28.98	0.00	0.00	30.68	0.00	0.00
2000	23.40	0.00	34.04	0.00	0.00	28.98	37.53	0.00	30.26	0.00	41.43
2001	27.89	28.38	28.51	0.00	46.52	29.77	39.81	0.00	29.94	0.00	33.14
2002	31.58	24.50	27.76	0.00	0.00	29.58	27.82	31.37	29.34	37.86	34.67

Table 6.6.4 Soybean Cost Differential: Reach 4 and 3 vs Reach 1 to the US Gulf

Illinois North	Reach 3 vs Reach 1	Reach 4 vs Reach 1
1995		10.71
1996		6.69
1997		0.75
1998		0.95
1999		-0.19
2000		1.59
2001		2.97
2002		6.27
Iowa River		
1995		
1996		13.63
1997		
1998		2.64
1999		
2000		
2001		5.19
2002		5.44
Iowa West		
1995		1.47
1996		3.15
1997		4.66
1998		1.90
1999		1.94
2000		4.49
2001		3.13
2002		1.85
Minnesota		
1995	3.66	5.95
1996	1.10	-4.64
1997	-0.36	0.98
1998	-0.29	-1.51
1999	2.96	-3.09
2000	8.48	5.18
2001	7.35	4.66
2002	6.66	4.22
Minnesota River		
1995		
1996		
1997		
1998		
1999	-1.98	-2.80
2000	6.51	4.99
2001	6.17	4.12
2002	11.57	5.12
Northern Plains		
1995	5.94	
1996	8.15	-3.72
1997	0.85	5.70
1998	0.63	-0.25
1999	0.90	-0.81
2000	7.15	4.90
2001	10.27	6.30
2002	8.31	4.51

Table 6.6.5 Corn Cost Differential: Reach 3 vs Reach 1 to The US Gulf

Northern Plains	Reach 3 vs Reach 1
1995	
1996	
1997	6.65
1998	21.00
1999	23.31
2000	5.46
2001	7.92
2002	7.13
Minnesota	
1995	
1996	4.14
1997	2.24
1998	6.53
1999	
2000	7.40
2001	7.57
2002	8.99
Minnesota River	
1995	
1996	
1997	
1998	
1999	
2000	4.13
2001	6.81
2002	7.72

Table 6.6.6 Corn Cost Differential: Illinois North to Reach 4 vs Reach 1

	Weighted Average Rates (mt)			Cost Differential to US Gulf
	Reach 1	Reach 4	Differential	4 vs 1
1995	6.35	5.14	1.21	4.23
1996	11.58	7.16	4.42	1.02
1997	8.00	4.28	3.72	1.72
1998	5.68	4.34	1.34	4.10
1999	6.25	4.78	1.47	3.97
2000	3.33	4.86	-1.53	6.97
2001	3.19	3.82	-0.63	6.07
2002	3.98	5.75	-1.76	7.20

6.7 Shipping costs in Canada and Brazil. Shipping costs for Canada were taken from The CN rail tariffs to The export locations and to US destinations. For Brazil, we used shipping and handling costs from ANTAQ (Governo Federal). These values show shipping costs from each of The producing regions in Brazil South and Brazil North, to The respective port areas.

6.8 Ocean rates Ocean freight rate data were obtained from Maritime Research Institute. World wide shipping rates from 1994 to 2004. The data consisted of origin, destination, rate, size of vessel, date, and commodity. Miles between ports were obtained from U.S. Defense Mapping Agency. Oil prices were obtained from DRI-WEFA.

A double log equation was used because of The non-linearity of The ocean rate schedule. Ocean tariffs are a function of size of vessel, miles between ports, oil prices, trend, and a series of dummy variables representing origins and destinations.

$Rate_{odt} = f(Size_{odt}, Mile_{odt}, Oil_t, D_{ec}, D_{eu} , D_{su}, D_{gf} , D_{wc} , D_{br}, D_{ca} , D_{sa} , D_{ch} , D_{sea} ,Trend)$

where

o=origins,
d= destinations,
t= year.

The subscripts on The dummy variables are origins:

ec= east coast United States;
eu= Europe;
su= Former Soviet Union;
gf=gulf port United States;
wc=west coast United States;
br= Brazil north or Brazil south;

and for destinations:

ca=Central America;
sa=South America;
ch=China and
sea= South East Asia.

The regression results are shown in Table 6.8.1. Current and projected rates are shown in Tables 6.8.2 and 6.8.3.

Table 6.8.1. Estimated coefficients and t-values for The ocean tariff equation

	Coefficient(s)	t-value
Constant	4.02	10.41
Size	-0.55	-57.01
Mile	0.45	41.57
Oil	0.24	10.33
Dec	0.04	1.23
Deu	0.04	1.00
Dsu	-0.16	-3.35
Dgf	0.13	3.84
Dwc	0.03	0.72
Dbr	0.03	0.99
Dca	0.11	5.05
Dsa	0.23	8.62
Dch	0.03	2.60
Dsea	0.10	4.20
Trend	-0.00	-1.23
R Squared	0.42	

Table 6.8.2. Estimated Shipping Costs ($/MT)

	Brazil N	Brazil S	Korea	Mexico	Japan	N Africa
Arg	16	12	23	31	22	22
Aus	31	28	16	30	15	29
Canada E	20	24	24	25	23	18
Canada W	28	32	19	23	18	28
US East	19	24	23	17	21	25
US Gulf	22	28	24	14	23	23
US PNW	27	31	19	23	18	27
Europe	22	24	23	27	22	12
ME_FSU	21	22	17	28	16	11
Brazil N	100,000	100,000	26	20	25	21
Brazil S	100,000	100,000	24	28	24	22

	S Africa	Latin	China	S Asia	SE Asia	Europe
Arg	19	32	24	22	23	26
Aus	24	34	16	15	14	26
Canada E	27	27	26	25	27	11
Canada W	32	33	20	30	25	30
US E	27	27	24	27	30	11
US G	30	25	26	32	32	16
US P	32	26	20	26	25	30
Europe	24	43	23	26	28	100,000
ME_FSU	22	33	18	21	21	13
Brazil N	20	25	29	23	27	21
Brazil S	22	30	26	23	26	23

Table 6.8.3. Projected Ocean Tariffs for Selected Routes ($/MT)

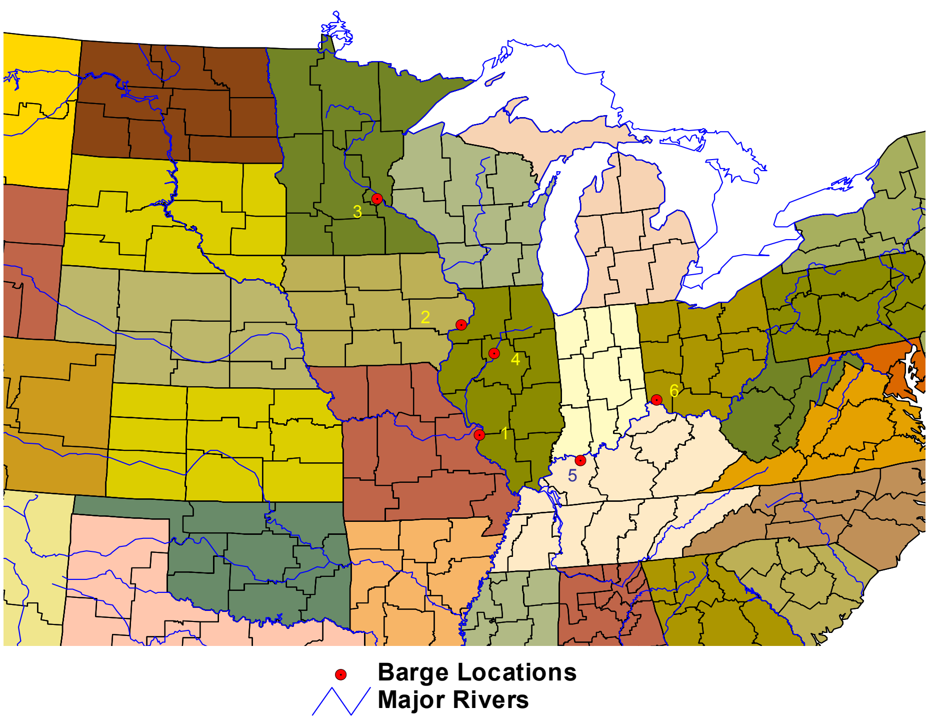
Origins	Destinations	2004	2010	2025	2050
Brazil N	China	29	28	29	31
Brazil S	China	26	25	26	28
US Gulf	China	26	25	26	28
US PNW	China	20	19	20	21
Brazil N	Japan	25	24	25	27
Brazil S	Japan	24	23	24	26
US Gulf	Japan	23	22	22	24
US PNW	Japan	18	17	18	19
Brazil N	SE Asia	27	26	27	29
Brazil S	SE Asia	26	25	26	28
US Gulf	SE Asia	32	31	32	35
US PNW	SE Asia	25	24	25	27

7. Logistical Constraints and Delay Costs

A series of logistical constraints and delay costs were developed and incorporated into the model. Specifically, there were three constraints that were imposed including barge delay costs, barge transfer in the St Louis area and rail transfer at the center Gulf. This section describes details behind each of these and at the end a summary is provided which explains their importance and implications.

For reference, we define 6 reaches as follows where cities are the geographical range of cities contained in the reach and the city in ( ) is the city used for deriving our shipping rates:

Reach 1	Cairo to LaGrange (St Louis)
Reach 2	LaGrange to McGregor (Davenport)
Reach 3	McGregor to Minneapolis (Minneapolis)
Reach 4	Illinois waterway (Peoria)
Reach 5	Ohio River Cairo to Louisville (Louisville)
Reach 6	Ohio River Cincinnati (Cincinnati)



7.1 Barge Delay Costs: The barge shipping cost was defined as $B=B_r + D$ where B_r is The rate defined as the tariff times the percent of tariff as defined in Section 6, and D is a "delay cost". A delay cost was defined for each of the reaches as discussed below.

The barge delay functions were derived by The US Army Corps of Engineers (ACE) following the procedures defined in Oak Ridge National Laboratory (2004). For Reaches 1-4, a delay cost was derived using simulation procedures. For Reaches 5 and 6, it was assumed after discussions with the ACE that the delay costs would be so inconsequential they were not derived. This is based on the contribution of the Ohio River to lower Mississippi River grain exports and the significantly greater lock capacities on the Ohio compared to the Mississippi.

To derive the delay costs, a barge capacity-volume relationship was estimated for each lock within the reach. Then, a model was developed where

Average wait time = f(volume); and,

Cost = f(wait time)

and results in hyperbolic function. Factors impacting the cost include value of grain, equipment and labor costs. These were defined relative to "normal traffic" assumed for other commodities, both upbound and downstream traffic, and reflect the incremental impact on cost for an assumed change in grain traffic. The delay costs for each reach represent the sum of the delay curves at individual locks within the reach. The values were annualized using procedures in Oak Ridge National Laboratory (2004) Section 1.1.3.2.2.

Delay costs for each reach reflect the cumulative impact of grains originating on that reach. Shipments originating upstream and going through a Reach are added to this total. There is an additional critical relationship between grain coming in from the Illinois River (Reach 4) and Reach 1 of the Mississippi River. The capacities of The 600 foot locks at Lock 21-25 are restrictive. For traffic coming on to the Mississippi River below St Louis (Lock 27) there are no locks and therefore no lock delays. Reach 4 traffic enters below the point of congestion. The effective limit on Reach 1 is in the area of 10 million tons over the portion of the reach with these locks.

The delay costs were measured under two assumptions with respect to improvements. The first assumes existing capacity and operating infrastructure and year 2000 traffic as the base. The second assumes the proposed improvements. Each of these have been proposed but not authorized by Congress, thus they should be viewed as potential improvements.[1] The values shown assumes the improvement is adopted and installed subject to base case traffic volume.

For Reach 3, The ACE had earlier determined that improvements would not be viable and consequently an expanded case is not represented. The locks in this reach operate at fairly

[1]Funding to initiate detailed design for several of the new locks as been provided for FY0-5 only.

low levels of utilization with current traffic. Even with expected future traffic increases, utilization remains low enough to prevent cost from dramatically increasing.

These results are shown in Figures 7.1 for each Reach. Interpretation of these values differ across reaches. For Reach 3 costs increase slightly with increases in traffic. For Reach 2, The increased costs associated with delay for traffic less than about 28 mmt is near nil. Costs increase very sharply for traffic greater than about 32 mmt. For Reach 1, which reflects the cumulative traffic of grain entering in either Reach 1 (above lock 27), 2 or 3, costs begin to increase for volumes greater than about 42 mmt. At traffic of about 48 mmt, the increase in delay costs is very sharp. Finally, at Reach 4, delay costs are near nil up to about 38 mmt and then increase sharply.

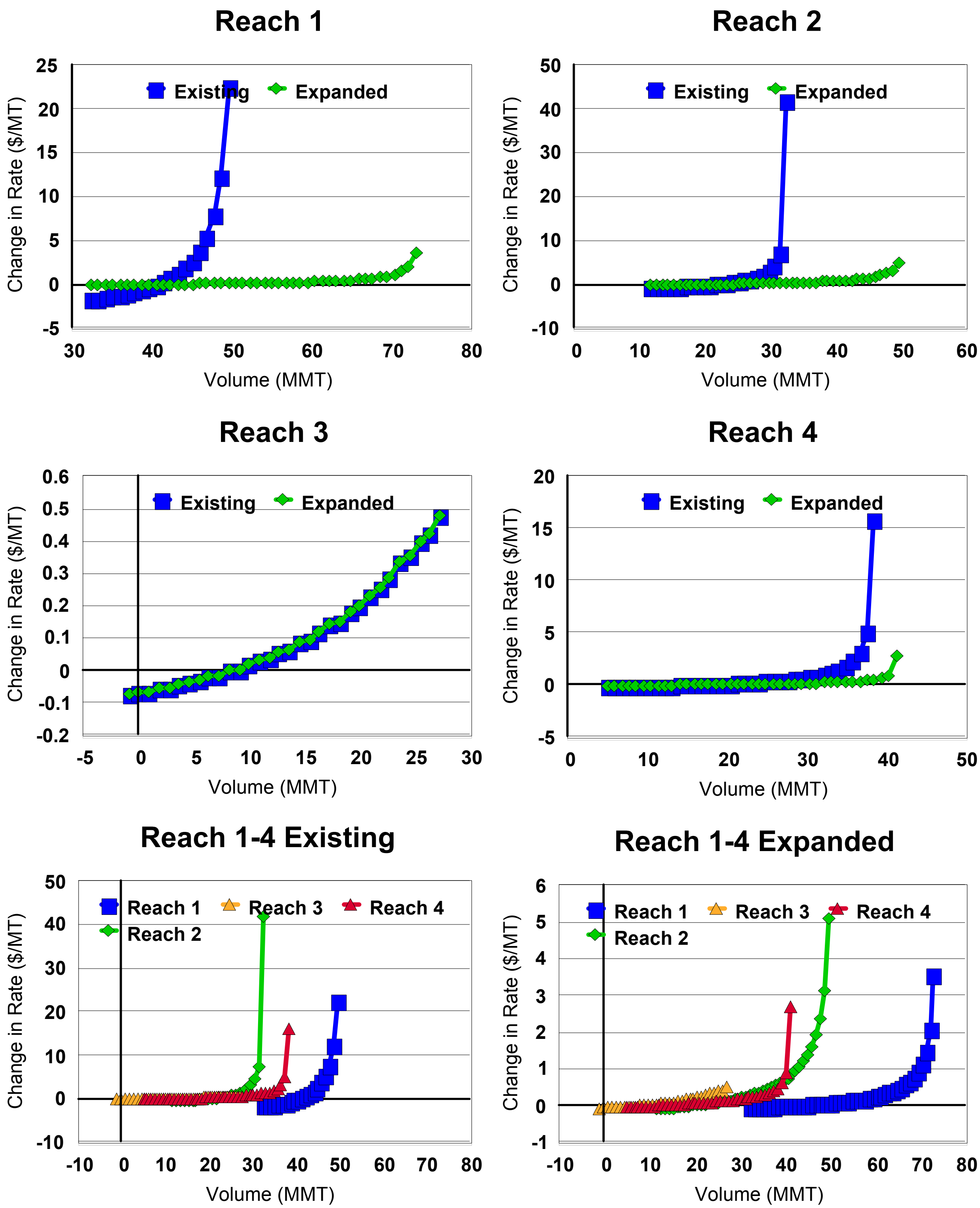


Figure 7.1. Relationship Between Change in Barge Rate and Volume by Reach and Existing vs. Expanded Capacity.

Interpretation of these are that for movements greater than these values, The delay costs increase, become exponential at different levels for each reach. It is this value that is defined as The capacity in the chance constrained model. Finally, the results illustrate the impact of the proposed improvements. Specifically, in each case the proposed improvements would have the impact of shifting the delay function rightwards meaning that near-nil delay costs would exist for a broader range of shipments.

This approach differs from Fuller et al. In that study, they estimated capacity delay function like transit curves for the entire river system, for a narrow range of capacity. They assumed that below 20% capacity, delay was negative, at 100% the maximum delay was 6 hours. Finally, they assumed an exogenous increase in traffic i.e. with 50% increase in traffic, 30% of corn was shifted off river. However, it was unclear where the exogenous 50% increase in traffic come from.

For calibration purposes and to put perspective on these delay costs, we assembled data on grain entering the river system on each of these reaches. These are shown in Figure 7.2-7.4 and the mean for each is shown in Figure 7.5 along with the delay curves. For example, on Reach 2 The grain entering the River ranged from 9 to 12.6 mmt over the past 9 years, and averaged about 10.6 mmt. This compares to delay costs that are near nil at that level and do not increase till volume approaches 30 mmt. Generally, for each of the reaches, the normal level of grain volume entering the river is far less than the point at which the delay costs become important.

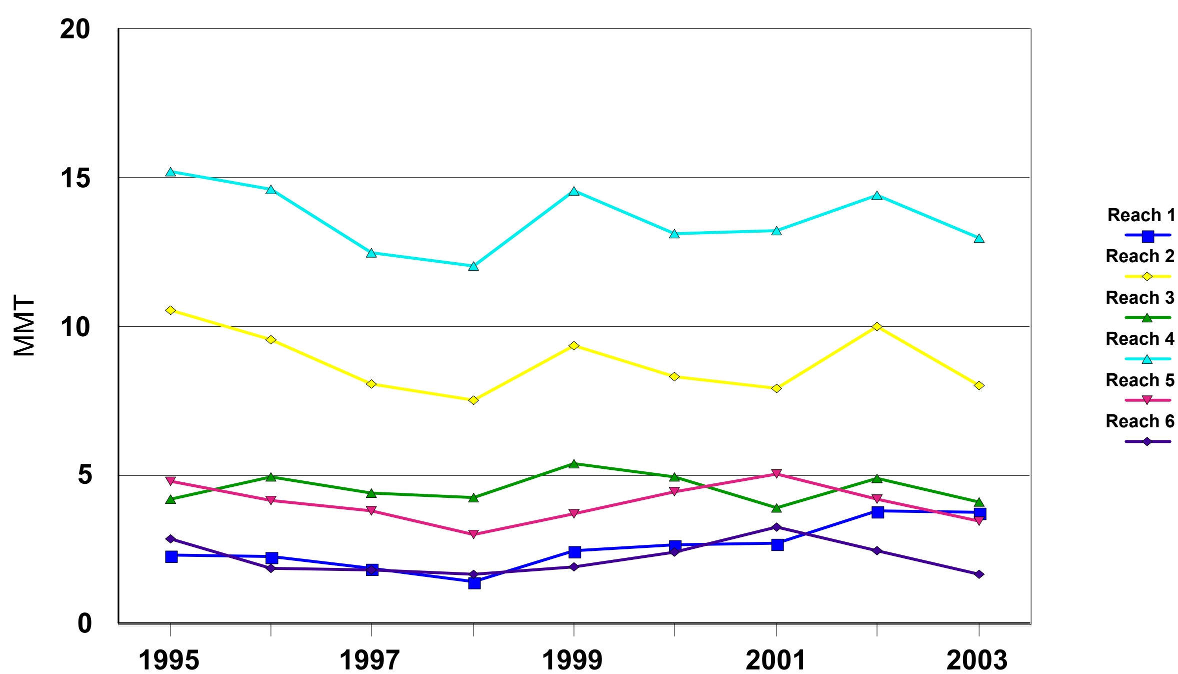


Figure 7.2 Barge Loading by Reach and Year (Corn, soybeans and wheat).

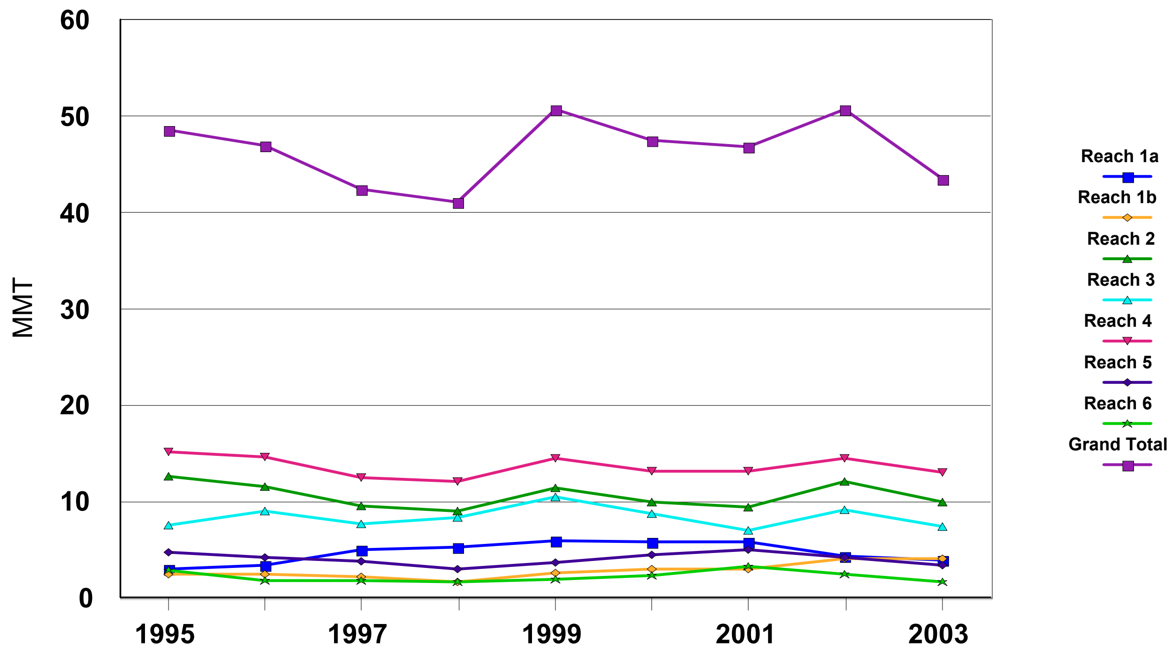


Figure 7.3 Barge Loadings by Reach, (Corn, Wheat and Soybeans), 1995-2003.

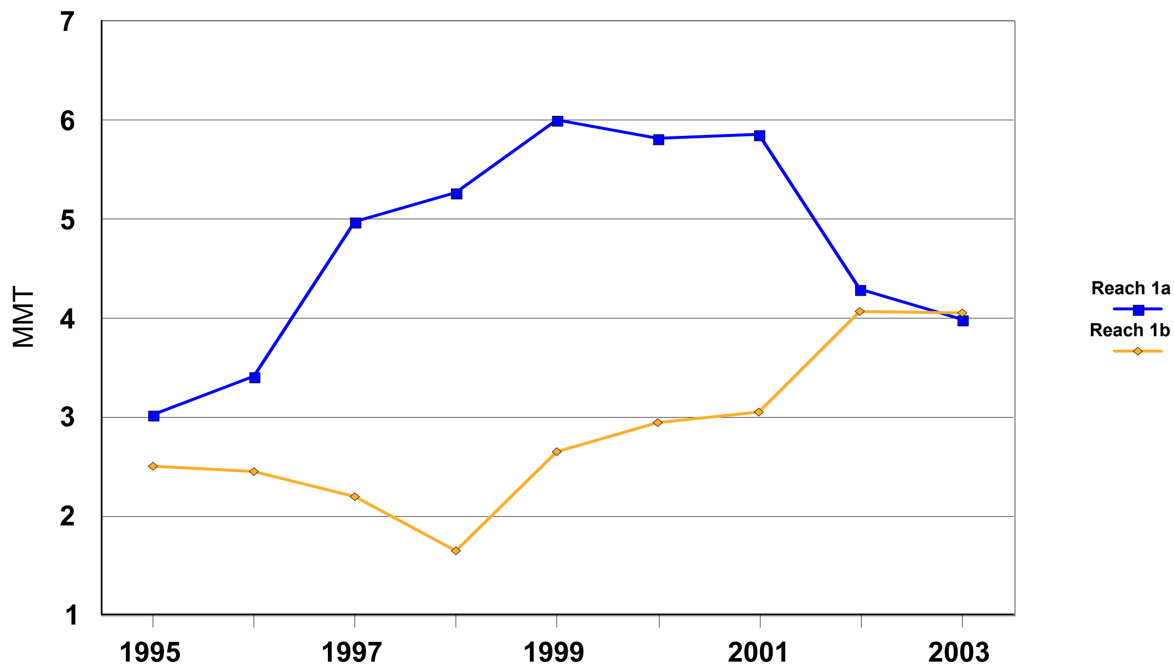


Figure 7.4 Barge Loadings for Reach 1a (below Lock 27) and Reach 1b (above Lock 27), 1995 to 2003.

7.2 Barge Transfer Constraints in St. Louis Area: An explicit restriction was imposed for grain entering the River system below the point of congestion in Reach 1. An important movement is for truck to the river in the lower portions of Reach 1, and for rail shipments from Northerly grain origins to St. Louis area elevators. Here is it transferred to barges, below the point at which the Reach is congested.

Historically, the volume of grain entering Reach 1 below Lock & Dam 27 is shown in Figure 7.2 as Reach 1b and that above Lock & Dam 27 is denoted as Reach 1b. This contrasts with that entering Reach 1 above this point which is shown in Figure 7.2. As illustrated about 4-5 mmt/year enter Reach 1 above Lock & Dam 27. Below this point, but within Reach 1 about 2.5 to 4 mmt/year has entered.[2] However, upon close examination, this has increased from about 2.5 in 1995 to 4.01 in 2003. The value used in our base case model was 6 mmt [3] which was slightly above the upper range of the maximum that occurred over the past 9 years. A set of sensitivities were conducted by relaxing this value.

These are shown along with the delay curves at each Reach in Figure 7.5. Now the results suggest that the volumes going through Reach 1 are near the point at which the delay costs escalate with exisiting capacity.

The nature and scope of this restriction can have several interpretations. First, it could be interpreted as a physical restriction on barge loading in this reach, given existing elevator infrastructure. There are many elevators in this region that currently receive grain by truck and rail, and can load up to 1.5 mmt/year each. In some cases these may be readily expandable and/or their expansion may be induced by railroad incentive mechanisms. Interviews conducted by the TVA indicated current annual utilization rate was between 30-40% of capacity in Reach 1. Seasonally there was some constraint for 30-60 days but not for the rest of the year.

Alternatively, it could be interpreted as a decision by railroads on The volume to ship to this region. Railroads continuously evaluate the volume they should ship to each port, and to this reach, to other reaches, as well as direct to the US Center Gulf. In addition, there may be rail track and operating restrictions that would limit the volume that could be transferred. In actuality, the value used in the restriction could be interpreted as either of these, or, more generally an equilibrium between barge transfer and rail deliveries.

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[2]This compares to grain entering Reach 1 inclusive of miles 1-242 of about 15 mmt in the 1990s and declining to 8-9 mmt in recent years. These were derived by the TVA and referenced in Fuller et al.

[3] Data from the TVA which includes L&D 27 has 1990-1996 at about 5 mmt; and 97, 98 and 99 at 6.8, 6.8 and 8.6 mmt respectively.

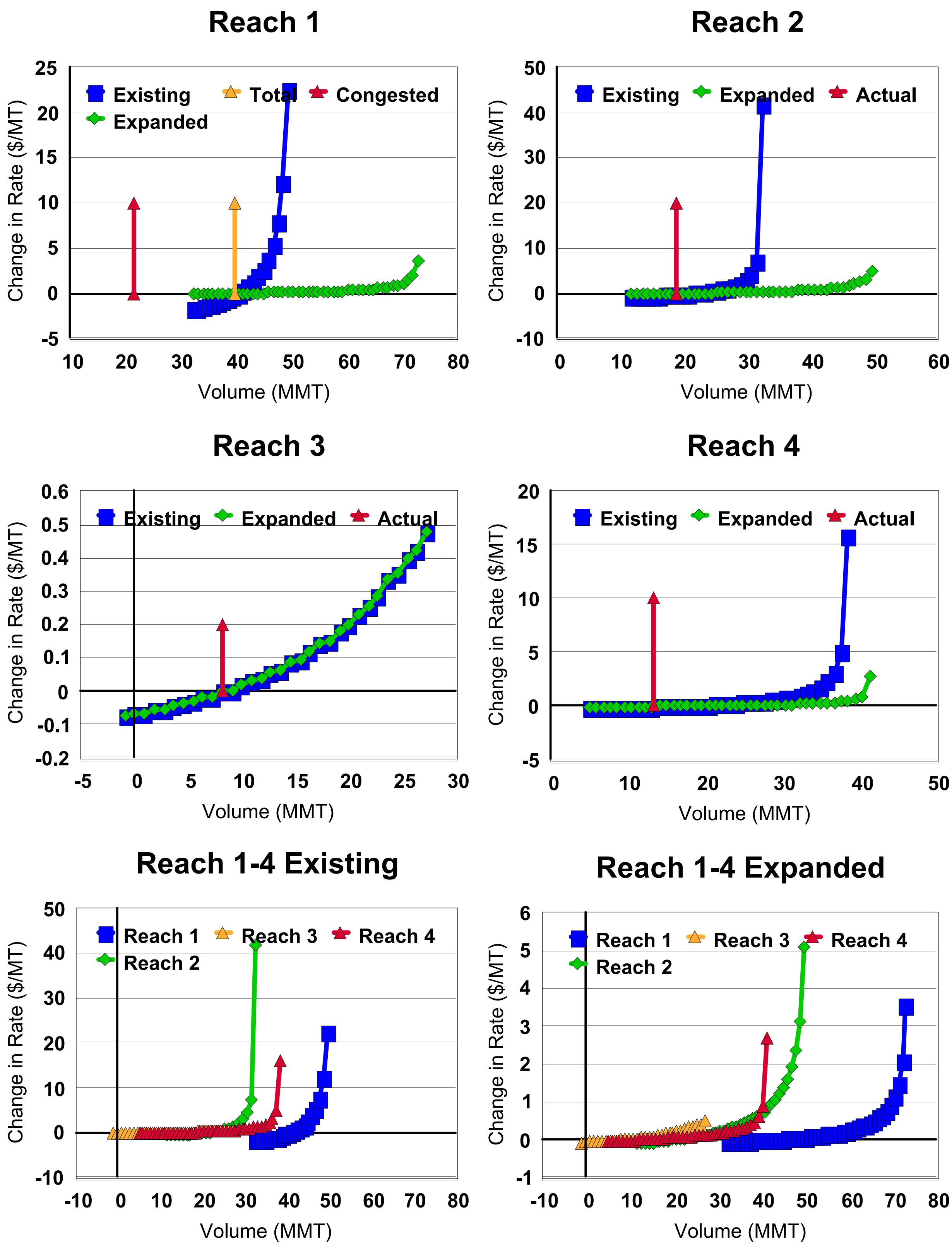

Figure 7.5. Relationship Between Change in Barge Rates and Volume with Average Actual Loadings, by Reach, Existing and Expanded Capacity.

Table 7.1 Rail Unloads at River Gulf (mmt)

Year	*Corn*	*Soy*	*Total*
1995	3.2	2.7	5.9
1996	2.0	1.0	3.1
1997	2.3	0.8	3.1
1998	2.6	1.6	4.2
1999	2.7	2.2	4.9
2000	2.6	2.3	4.9
2001	2.0	2.6	4.6
2002	1.8	2.4	4.3
2003	3.5	1.8	5.3
2004	3.2	1.9	5.1
2005	3.1	1.9	5.1
Average	2.6	1.9	4.6
Avg 95-2002	2.4	2.0	4.4
Max	3.5	2.7	5.9

Source: ProExporter, F-6. Wheat was not estimated and is near inconsequential.

7.3 Rail Transfer Constraints at US Gulf Upon further examination of the data on grain flows by mode and route, it was apparent there seems to be a limit on the rail volume that is or could be routinely unloaded from rail at The US Center Gulf. Historically, rail unloads at the center Gulf are shown in Table 7.1. Wheat is near inconsequential and not estimated. The maximum over this period is 5.9 mmt.

Thus, we imposed a rail supply capacity here to 6.0 mmt. Again, as above, this could be interpreted several ways. One is a physical limit on rail transfer on Gulf River elevators either due to track space, operating restrictions, or physical elevator limits. The alternative interpretation is that of railroad decisions on volume they would ship to the US Gulf vs other port areas and St Louis.

7.4 Summary and Implications: These are fairly critical assumptions that impact current flows on the river system, as well as longer term. In the short run, there are capacity restrictions on rail shipping and on barge transfer which otherwise limit rail shipments. Imposing these is appropriate for shorter-run simulations of the system in that they reflect operating restrictions. These are important restrictions that impact flows in addition to the relative shipping costs on rail versus barges. It is important that in recent years, rail shipping costs have declined in some of the critical movements, particularly to St Louis (Reach 1) and to the US Gulf. And, to these destinations, the amount of rail shipments has increased. Though this has not occurred from all origins, it has occurred in some of the critical large volume origins.

The impact of these restrictions is essentially to add costs to barges for larger volumes, and to limit the volume of grain on rail at these key points. In so doing, this has the impact of forcing more grain onto the river in Reaches 2-4, which has the effect of avoiding the restriction on unloading at Reach 1 and at the Center Gulf. These limit grain on rail, and force it to enter the river upstream from Reach 1. Of course, the value of the restrictions impact how much is diverted.

Longer-term however, one has to beg the question of why these capacities are not increased (if they can). Thus, for our calibration, we retain the restrictions and then conduct sensitivities to illustrate the impact of relaxing the values. Finally, in the risk analysis, some of this is averted as we will have rate functions capturing part of this impact.

8. International Trade Policies

A matrix of agricultural policies and trade mechanisms were included in The model. These were from varying sources including the USDA-ERS WTO Trade Policy Commitments Database and Agricultural Market Access Database (www.amad.org). While there are a multitude of sources for these data, those used were summarized in terms of domestic subsidies, export subsidies and import tariffs.

Domestic subsidies are shown in Table 8.1. Export subsidies are in Table 8.2. Argentina has an export tax which is comparable to a negative export subsidy. That value shown for Australia is for The research tax levy applied on all exports.

Import tariffs are shown in Table 8.3. In addition to these, several regional specific tariffs were included. These include: MERCUSOR: Trade between these countries is assumed at nil tariffs; and US/Canada in which an import tariff from Canada to the US at 14.2% was applied. Finally, a variable import levy was applied to imports into the EU.

Table 8.1 Domestic Subsidies

	Wheat	Corn	Soybean
		Percent	
Canada	5	5	5
EU	30	30	30
Japan	5	50	50
S. Korea	50	50	50
United States	6	7	8

Source: USDA-ERS

Table 8.2 Export Subsidies

	Wheat	Corn	Soybean
		Percent	
Argentina	-30	-30	-30
Australia	-1.1	-1.1	-1.1
EU	27.4	19.9	0

Source: USDA-ERS and personal communications.

Table 8.3 Import Tariffs

	Wheat	Corn	Soybean
		Percent	
Brazil	69.3	0	30.4
China	0	81.1	18.9
EU	0	88.2	11.8
FSU	50.7	5.5	43.8
Japan	61.7	18.6	19.8
S Korea	66.3	10.5	23.2
Latin America	51.7	0	48.3
Mexico	53.4	32.9	13.7
N. Africa	20.5	3.8	75.7
S Africa	27.3	0	72.7
S Asia	93.8	6.2	0
SE Asia	39.8	17.0	43.3

Source: USDA-ERS.

9. Spatial Arbitrage: Simple Comparison of Costs on Selected Origins/Routes

9.1 Purpose: Ultimately there are many cost elements that impact The spatial distribution of grains. These include but are not limited to production costs (in order to derive landed or delivered costs at The point of import), interior shipping costs, handling and other logistics costs, and ocean shipping costs.

The analysis in this section compares intermarket competition and the spatial distribution of grains. The intention is to identify the impact of the individual costs elements relative to other costs, and relative to competing regions, and how they impact shipments through the river system. The analysis examines the intermarket competitiveness among US regions for shipments to Japan and China. Thus, these should be viewed as microscopic analysis of shipments from some of the most important origins to the most important destinations for Canal swing traffic.

These are base case values for costs and illustrate The components of costs that impact intermarket shipments. The spatial competitive model (Section 10 below) captures all of these costs. Thus, what is shown here is viewed as illustrative of the cost elements. The difference is that the spatial competition model also includes supplies and demands for each grain and each importing and exporting country.

Results are shown in Tables 9.1-9.3 Corn, Soybeans, and Wheat to Japan and Tables 9.4-9.6 to China. These derivations use ocean shipping costs for corn of: $22.57/mt from US Gulf to Japan and $17.60/mt from PNW to Japan; those to China were $25.64 and $19.66 respectively from the US Gulf and PNW. And, barge transfer costs were $1.47/mt where applicable.

9.2 Results Within The US grains can easily shift to the US Gulf or PNW depending on the cumulative cost of shipping from origin to destinations. This analysis investigated the elements of costs that impact these decisions.

Some regions within the US have a large advantage going to Asia through the US Gulf, while others have a large advantage of going through the PNW ports. Based on these, some interesting include:

Corn to Japan: For shipments from US regions, shipments from the US Gulf are generally lower cost when comparing costs of transportation and total costs including cost of production. For only USCPLAINSR is the PNW a lower cost alternative. For these Gulf shipments, the lowest cost sources are generally for barge delivery instead of direct rail, although the advantage in total costs for barge over rail vary from 14.31 to-7.85)

Wheat to Japan: For shipments from US regions, shipments from the PNW are lower cost from the USPNW, USWEST and USWNPLAINS production regions than for other ports. From other regions, rates from Gulf via barge are the only ones available for many production regions, yet direct rail is preferred to barge shipment for USNPLAINS, USMN, USILNorth, USCPLAINS and USCPLAINSR. Thus, as we move east and south across the U.S. production regions, there is a shift from PNW being dominant port for export to direct rail to the gulf being preferred to gulf barge being low cost shipment option. Overall the lowest total cost of supplies was from USILNorth via barge to Gulf which totaled $75.87/MT. Total costs were highest from USSPLAINS via Gulf barge at $172.14/MT, USWEST and USWNPLAINS at $130.62/MT to $142.42/MT via the PNW and NPLAINS via direct rail to Gulf at $141.68/MT. The high cost for the USSPLAINS is due to high cost of production relative to other regions which primarily comes from The low yields relative to other areas.

<u>Soybeans to Japan and China</u>: The lowest costs origins for shipping soybeans to Japan are Illinois North (USILNorth) and Indiana South (USILSouth). The US Gulf is the lowest cost port from all origins with the exception of the PNW, West and Northern Plains. In these cases, the PNW is the lowest cost route.

Table 9.1. Comparison of Corn Shipment Costs to Japan by U.S. Production Regions.

				Rail to Export			Minimum Truck/Rail to Barge Locations +Barge to Louisiana						Barge Handle	Ocean Shipping	
ProdReg	Prod. Cost	Yield	Prod Cost	NOLA	TXGulf	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6		PNW	Gulf
	$/HA	MT/HA	$/MT						$/MT						
USCPLAINS	488	7.0	70.10	27.81	43.03	28.05	18.49	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USCPLAINSR	488	6.1	79.66	21.24	21.15	24.34	24.45	31.79	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USDELTA	10000	7.3	NA	6.13	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USILNorth	381	9.2	41.33	10.49	NA	NA	8.97	18.79	35.62	13.05	22.88	25.47	1.47	17.60	22.57
USILSouth	381	7.0	54.61	9.22	NA	NA	8.25	27.30	1000.00	13.09	16.76	24.27	1.47	17.60	22.57
USINNorth	381	7.7	49.51	NA	NA	NA	9.29	28.39	1000.00	16.68	19.53	17.40	1.47	17.60	22.57
USINRiver	381	5.8	65.93	NA	NA	NA	12.75	18.11	1000.00	18.27	12.79	16.44	1.47	17.60	22.57
USIowaR	381	10.4	36.52	NA	NA	NA	18.14	17.94	31.43	20.07	1000.00	1000.00	1.47	17.60	22.57
USIowaW	381	9.8	38.65	21.61	22.79	NA	17.49	26.52	30.70	22.94	1000.00	1000.00	1.47	17.60	22.57
USMI	401	6.5	61.45	NA	NA	NA	17.99	21.86	26.98	22.44	1000.00	26.40	1.47	17.60	22.57
USMN	401	8.8	45.59	NA	25.53	25.59	16.28	20.98	23.99	21.41	1000.00	1000.00	1.47	17.60	22.57
USMNR	381	9.4	40.33	25.86	NA	26.47	10.09	30.49	19.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USMOR	381	5.7	67.20	NA	NA	NA	9.65	25.12	1000.00	20.57	21.17	27.26	1.47	17.60	22.57
USMOW	381	6.6	57.78	18.51	NA	35.39	14.29	28.60	31.31	25.18	23.93	1000.00	1.47	17.60	22.57
USNE	401	2.8	142.37	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USNPLAINS	10000	4.7	NA	NA	NA	25.03	1000.00	1000.00	36.20	1000.00	1000.00	1000.00	1.47	17.60	22.57
USOH	401	5.1	78.57	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	24.02	16.61	1.47	17.60	22.57
USPNW	10000	4.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USSE	407	4.9	82.73	6.61	NA	NA	12.57	1000.00	1000.00	17.84	1000.00	1000.00	1.47	17.60	22.57
USSPLAINS	488	6.1	80.32	NA	11.06	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USWEST	10000	3.1	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USWiscS	401	6.7	60.08	NA	NA	NA	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	17.60	22.57
USWiscW	401	6.9	58.43	NA	NA	NA	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	17.60	22.57
USWNPLAINS	10000	2.6	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57

*Values of 1000 indicate that at least one component of the rate was not accessible.

Table 9.1. (Continued) Comparison of Corn Shipment Costs to Japan by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	45.65	50.38	42.53	115.75	120.48	112.63
USCPLAINSR	41.94	43.72	48.49	121.60	123.38	128.15
USDELTA	NA	28.70	NA			
USILNorth	NA	33.06	33.01		74.39	74.34
USILSouth	NA	31.79	32.29		86.40	86.90
USINNorth	NA	NA	33.33			82.84
USINRiver	NA	NA	36.79			102.72
USIowaR	NA	NA	41.98			78.50
USIowaW	NA	44.18	41.53		82.83	80.19
USMI	NA	NA	42.03			103.48
USMN	43.19	48.10	40.32	88.77	93.68	85.91
USMNR	44.07	48.43	34.13	84.40	88.76	74.46
USMOR	NA	NA	33.69			100.89
USMOW	52.99	41.08	38.33	110.77	98.87	96.12
USNE	NA	NA	NA			
USNPLAINS	42.63	NA	60.24			
USOH	NA	NA	40.65			119.23
USPNW	NA	NA	NA			
USSE	NA	29.18	36.61		111.91	119.34
USSPLAINS	NA	33.63	NA		113.94	
USWEST	NA	NA	NA			
USWiscS	NA	NA	50.10			110.18
USWiscW	NA	NA	49.89			108.32
USWNPLAINS	NA	NA	NA			

Table 9.2. Comparison of Wheat Shipment Costs to Japan by U.S. Production Regions.

				Rail to Export			Minimum Truck/Rail to Barge Locations +Barge to Louisiana						Barge Handle	Ocean Shipping	
ProdReg	Prod. Cost	Yield	Prod Cost	NOLA	TXGulf	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6		PNW	Gulf
	$/HA	MT/HA	$/MT						$/MT						
USCPLAINS	127	1.7	75.71	22.92	22.33	35.38	22.96	33.94	42.86	29.69	1000.00	1000.00	1.47	17.60	22.57
USCPLAINSR	127	2.6	49.07	21.25	18.41	NA	19.04	31.79	40.96	25.73	1000.00	1000.00	1.47	17.60	22.57
USDELTA	10000	2.6	NA	8.21	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USILNorth	177	4.0	43.87	9.43	20.60	NA	16.36	18.79	35.62	13.05	22.88	25.47	1.47	17.60	22.57
USILSouth	177	2.9	60.00	NA	NA	NA	9.22	27.30	1000.00	21.54	16.76	24.27	1.47	17.60	22.57
USINNorth	177	3.7	47.49	NA	NA	NA	15.77	28.39	1000.00	22.90	19.53	17.40	1.47	17.60	22.57
USINRiver	177	2.9	61.05	NA	NA	NA	11.81	30.74	1000.00	24.95	12.79	16.44	1.47	17.60	22.57
USIowaR	177	2.8	62.81	NA	NA	NA	16.59	17.94	31.43	19.02	1000.00	1000.00	1.47	17.60	22.57
USIowaW	177	2.9	60.10	NA	NA	NA	23.77	26.52	30.70	26.89	1000.00	1000.00	1.47	17.60	22.57
USMI	10000	4.4	NA	NA	NA	NA	14.27	32.31	22.91	19.94	1000.00	26.40	1.47	17.60	22.57
USMN	126	2.1	61.40	NA	24.88	37.58	15.50	1000.00	28.38	1000.00	1000.00	1000.00	1.47	17.60	22.57
USMNR	177	2.2	80.76	NA	NA	NA	46.99	30.49	19.00	58.93	1000.00	1000.00	1.47	17.60	22.57
USMOR	177	2.9	60.48	NA	NA	NA	9.65	25.12	43.05	20.57	21.17	27.26	1.47	17.60	22.57
USMOW	177	2.5	70.93	23.33	18.36	NA	14.29	28.60	1000.00	23.50	23.93	1000.00	1.47	17.60	22.57
USNE	10000	3.8	NA	NA	NA	NA	31.10	1000.00	44.49	1000.00	1000.00	1000.00	1.47	17.60	22.57
USNPLAINS	126	1.4	87.20	33.53	31.91	47.45	1000.00	1000.00	36.20	1000.00	1000.00	1000.00	1.47	17.60	22.57
USOH	10000	3.9	NA	11.75	NA	NA	36.97	1000.00	1000.00	42.41	24.02	16.61	1.47	17.60	22.57
USPNW	296	3.6	82.36	NA	32.05	14.13	43.64	1000.00	1000.00	50.65	1000.00	1000.00	1.47	17.60	22.57
USSE	241	2.0	118.38	NA	NA	NA	15.95	1000.00	1000.00	18.51	1000.00	1000.00	1.47	17.60	22.57
USSPLAINS	127	1.0	133.09	18.82	18.89	NA	15.01	1000.00	1000.00	20.45	1000.00	1000.00	1.47	17.60	22.57
USWEST	296	3.4	86.71	NA	26.81	26.31	56.74	1000.00	1000.00	52.00	1000.00	1000.00	1.47	17.60	22.57
USWiscS	10000	3.7	NA	NA	26.81	26.31	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	17.60	22.57
USWiscW	10000	3.0	NA	NA	26.81	26.31	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	17.60	22.57
USWNPLAINS	126	1.3	98.51	NA	26.81	26.31	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57

*Values of 1000 indicate The at least one component of The rate was not accessible.

Table 9.2. (Continued) Comparison of Wheat Shipment Costs to Japan by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	52.98	44.90	47.00	128.70	120.61	122.71
USCPLAINSR	NA	40.98	43.08		90.05	92.14
USDELTA	NA	30.78	NA			
USILNorth	NA	32.00	37.09		75.87	80.96
USILSouth	NA	NA	33.26			93.26
USINNorth	NA	NA	39.81			87.30
USINRiver	NA	NA	35.85			96.89
USIowaR	NA	NA	40.63			103.44
USIowaW	NA	NA	47.81			107.90
USMI	NA	NA	38.31			
USMN	55.18	47.45	39.54	116.59	108.85	100.95
USMNR	NA	NA	43.04			123.80
USMOR	NA	NA	33.69			94.17
USMOW	NA	40.93	38.33		111.86	109.27
USNE	NA	NA	55.14			
USNPLAINS	65.05	54.48	60.24	152.25	141.68	147.44
USOH	NA	34.32	40.65			
USPNW	31.73	54.62	67.68	114.10	136.98	150.05
USSE	NA	NA	39.99			158.37
USSPLAINS	NA	41.39	39.05		174.47	172.14
USWEST	43.91	49.38	76.04	130.62	136.09	162.75
USWiscS	43.91	49.38	50.10			
USWiscW	43.91	49.38	49.89			
USWNPLAINS	43.91	49.38	NA	142.42	147.89	

Table 9.3. Comparison of Soybeans Shipment Costs to Japan by U.S. Production Regions.

ProdReg	Prod. Cost	Yield	Prod Cost	Rail to Export NOLA	Rail to Export TXGulf	Rail to Export PNW	Minimum Truck/Rail to Barge Locations +Barge to Louisiana Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Barge Handle	Ocean Shipping PNW	Ocean Shipping Gulf
	$/HA	MT/HA	$/MT				$/MT								
USCPLAINS	10000	2.3	NA	20.69	17.67	31.58	14.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USCPLAINSR	10000	2.0	NA	17.33	17.58	24.50	10.13	31.79	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USDELTA	234	2.1	111.77	9.58	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USILNorth	195	3.2	60.12	12.25	NA	27.76	11.63	18.79	35.62	13.05	22.88	25.47	1.47	17.60	22.57
USILSouth	195	2.4	79.85	11.26	NA	NA	9.22	27.30	1000.00	21.54	16.76	24.27	1.47	17.60	22.57
USINNorth	195	2.9	67.51	NA	NA	NA	10.42	28.39	1000.00	22.90	19.53	17.40	1.47	17.60	22.57
USINRiver	195	2.2	90.06	NA	NA	NA	12.01	30.74	1000.00	17.45	12.79	16.44	1.47	17.60	22.57
USIowaR	195	3.3	59.57	13.43	NA	NA	17.70	17.94	31.43	19.55	1000.00	1000.00	1.47	17.60	22.57
USIowaW	195	3.2	60.92	21.38	NA	NA	23.77	26.52	30.70	26.89	1000.00	1000.00	1.47	17.60	22.57
USMI	10000	2.6	NA	108.14	NA	NA	20.97	32.31	27.63	25.20	1000.00	26.40	1.47	17.60	22.57
USMN	177	2.6	67.32	23.47	NA	29.58	16.18	20.66	27.75	21.30	1000.00	1000.00	1.47	17.60	22.57
USMNR	195	3.2	60.89	21.97	NA	27.82	9.12	30.49	19.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USMOR	195	2.5	77.52	NA	NA	NA	9.65	18.49	1000.00	20.57	21.17	27.26	1.47	17.60	22.57
USMOW	195	2.2	88.77	15.53	27.10	31.37	14.29	28.60	1000.00	25.18	23.93	1000.00	1.47	17.60	22.57
USNE	10000	1.7	NA	NA	NA	NA	22.72	31.67	31.03	27.23	1000.00	1000.00	1.47	17.60	22.57
USNPLAINS	177	2.1	85.51	25.11	23.76	29.34	17.83	1000.00	36.20	33.72	1000.00	1000.00	1.47	17.60	22.57
USOH	10000	2.1	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	24.02	16.61	1.47	17.60	22.57
USPNW	10000	0.0	NA	NA	NA	37.86	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USSE	250	1.8	142.41	12.68	NA	34.67	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USSPLAINS	10000	1.6	NA	27.01	12.53	NA	12.55	1000.00	1000.00	17.99	1000.00	1000.00	1.47	17.60	22.57
USWEST	10000	0.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57
USWiscS	10000	2.9	NA	NA	NA	NA	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	17.60	22.57
USWiscW	10000	3.1	NA	NA	NA	NA	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	17.60	22.57
USWNPLAINS	177	0.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	17.60	22.57

*Values of 1000 indicate The at least one component of The rate was not accessible.

Table 9.3. (Continued) Comparison of Soybeans Shipment Costs to Japan by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	49.18	40.24	38.04			
USCPLAINSR	42.10	39.90	34.17			
USDELTA	NA	32.15	NA		143.92	
USILNorth	45.36	34.82	35.67	105.49	94.94	95.79
USILSouth	NA	33.83	33.26		113.68	113.11
USINNorth	NA	NA	34.46			101.97
USINRiver	NA	NA	36.05			126.11
USIowaR	NA	36.00	41.74		95.57	101.31
USIowaW	NA	43.95	47.81		104.87	108.73
USMI	NA	130.71	45.01			
USMN	47.18	46.04	40.22	114.51	113.36	107.55
USMNR	45.42	44.54	33.16	106.31	105.43	94.05
USMOR	NA	NA	33.69			111.21
USMOW	48.97	38.10	38.33	137.74	126.87	127.10
USNE	NA	NA	46.76			
USNPLAINS	46.94	46.33	41.87	132.45	131.84	127.38
USOH	NA	NA	40.65			
USPNW	55.46	NA	NA			
USSE	52.27	35.25	NA	194.68	177.66	
USSPLAINS	NA	35.10	36.59			
USWEST	NA	NA	NA			
USWiscS	NA	NA	50.10			
USWiscW	NA	NA	49.89			
USWNPLAINS	NA	NA	NA			

Table 9.4. Comparison of Corn Shipment Costs to China by U.S. Production Regions.

				Rail to Export			Minimum Truck/Rail to Barge Locations +Barge to Louisiana						Barge Handle	Ocean Shipping	
ProdReg	Prod. Cost	Yield	Prod Cost	NOLA	TXGulf	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6		PNW	Gulf
	$/HA	MT/HA	$/MT						$/MT						
USCPLAINS	488	7.0	70.10	27.81	43.03	28.05	18.49	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USCPLAINSR	488	6.1	79.66	21.24	21.15	24.34	24.45	31.79	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USDELTA	10000	7.3	NA	6.13	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USILNorth	381	9.2	41.33	10.49	NA	NA	8.97	18.79	35.62	13.05	22.88	25.47	1.47	19.66	25.64
USILSouth	381	7.0	54.61	9.22	NA	NA	8.25	27.30	1000.00	13.09	16.76	24.27	1.47	19.66	25.64
USINNorth	381	7.7	49.51	NA	NA	NA	9.29	28.39	1000.00	16.68	19.53	17.40	1.47	19.66	25.64
USINRiver	381	5.8	65.93	NA	NA	NA	12.75	18.11	1000.00	18.27	12.79	16.44	1.47	19.66	25.64
USIowaR	381	10.4	36.52	NA	NA	NA	18.14	17.94	31.43	20.07	1000.00	1000.00	1.47	19.66	25.64
USIowaW	381	9.8	38.65	21.61	22.79	NA	17.49	26.52	30.70	22.94	1000.00	1000.00	1.47	19.66	25.64
USMI	401	6.5	61.45	NA	NA	NA	17.99	21.86	26.98	22.44	1000.00	26.40	1.47	19.66	25.64
USMN	401	8.8	45.59	NA	25.53	25.59	16.28	20.98	23.99	21.41	1000.00	1000.00	1.47	19.66	25.64
USMNR	381	9.4	40.33	25.86	NA	26.47	10.09	30.49	19.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USMOR	381	5.7	67.20	NA	NA	NA	9.65	25.12	1000.00	20.57	21.17	27.26	1.47	19.66	25.64
USMOW	381	6.6	57.78	18.51	NA	35.39	14.29	28.60	31.31	25.18	23.93	1000.00	1.47	19.66	25.64
USNE	401	2.8	142.37	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USNPLAINS	10000	4.7	NA	NA	NA	25.03	1000.00	1000.00	36.20	1000.00	1000.00	1000.00	1.47	19.66	25.64
USOH	401	5.1	78.57	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	24.02	16.61	1.47	19.66	25.64
USPNW	10000	4.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USSE	407	4.9	82.73	6.61	NA	NA	12.57	1000.00	1000.00	17.84	1000.00	1000.00	1.47	19.66	25.64
USSPLAINS	488	6.1	80.32	NA	11.06	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USWEST	10000	3.1	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USWiscS	401	6.7	60.08	NA	NA	NA	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	19.66	25.64
USWiscW	401	6.9	58.43	NA	NA	NA	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	19.66	25.64
USWNPLAINS	10000	2.6	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64

*Values of 1000 indicate The at least one component of The rate was not accessible.

Table 9.4. (Continued) Comparison of Corn Shipment Costs to China by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	47.71	53.45	45.60	117.81	123.55	115.70
USCPLAINSR	44.00	46.79	51.56	123.66	126.45	131.22
USDELTA	NA	31.77	NA			
USILNorth	NA	36.13	36.08		77.46	77.41
USILSouth	NA	34.86	35.36		89.47	89.97
USINNorth	NA	NA	36.40			85.91
USINRiver	NA	NA	39.86			105.79
USIowaR	NA	NA	45.05			81.57
USIowaW	NA	47.25	44.60		85.90	83.26
USMI	NA	NA	45.10			106.55
USMN	45.25	51.17	43.39	90.83	96.75	88.98
USMNR	46.13	51.50	37.20	86.46	91.83	77.53
USMOR	NA	NA	36.76			103.96
USMOW	55.05	44.15	41.40	112.83	101.94	99.19
USNE	NA	NA	NA			
USNPLAINS	44.69	NA	63.31			
USOH	NA	NA	43.72			122.30
USPNW	NA	NA	NA			
USSE	NA	32.25	39.68		114.98	122.41
USSPLAINS	NA	36.70	NA		117.01	
USWEST	NA	NA	NA			
USWiscS	NA	NA	53.17			113.25
USWiscW	NA	NA	52.96			111.39
USWNPLAINS	NA	NA	NA			

Table 9.5. Comparison of Wheat Shipment Costs to China by U.S. Production Regions.

ProdReg	Prod. Cost	Yield	Prod Cost	Rail to Export			Minimum Truck/Rail to Barge Locations +Barge to Louisiana						Barge Handle	Ocean Shipping	
				NOLA	TXGulf	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6		PNW	Gulf
	$/HA	MT/HA	$/MT	$/MT											
USCPLAINS	127	1.7	75.71	22.92	22.33	35.38	22.96	33.94	42.86	29.69	1000.00	1000.00	1.47	19.66	25.64
USCPLAINSR	127	2.6	49.07	21.25	18.41	NA	19.04	31.79	40.96	25.73	1000.00	1000.00	1.47	19.66	25.64
USDELTA	10000	2.6	NA	8.21	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USILNorth	177	4.0	43.87	9.43	20.60	NA	16.36	18.79	35.62	13.05	22.88	25.47	1.47	19.66	25.64
USILSouth	177	2.9	60.00	NA	NA	NA	9.22	27.30	1000.00	21.54	16.76	24.27	1.47	19.66	25.64
USINNorth	177	3.7	47.49	NA	NA	NA	15.77	28.39	1000.00	22.90	19.53	17.40	1.47	19.66	25.64
USINRiver	177	2.9	61.05	NA	NA	NA	11.81	30.74	1000.00	24.95	12.79	16.44	1.47	19.66	25.64
USIowaR	177	2.8	62.81	NA	NA	NA	16.59	17.94	31.43	19.02	1000.00	1000.00	1.47	19.66	25.64
USIowaW	177	2.9	60.10	NA	NA	NA	23.77	26.52	30.70	26.89	1000.00	1000.00	1.47	19.66	25.64
USMI	10000	4.4	NA	NA	NA	NA	14.27	32.31	22.91	19.94	1000.00	26.40	1.47	19.66	25.64
USMN	126	2.1	61.40	NA	24.88	37.58	15.50	1000.00	28.38	1000.00	1000.00	1000.00	1.47	19.66	25.64
USMNR	177	2.2	80.76	NA	NA	NA	46.99	30.49	19.00	58.93	1000.00	1000.00	1.47	19.66	25.64
USMOR	177	2.9	60.48	NA	NA	NA	9.65	25.12	43.05	20.57	21.17	27.26	1.47	19.66	25.64
USMOW	177	2.5	70.93	23.33	18.36	NA	14.29	28.60	1000.00	23.50	23.93	1000.00	1.47	19.66	25.64
USNE	10000	3.8	NA	NA	NA	NA	31.10	1000.00	44.49	1000.00	1000.00	1000.00	1.47	19.66	25.64
USNPLAINS	126	1.4	87.20	33.53	31.91	47.45	1000.00	1000.00	36.20	1000.00	1000.00	1000.00	1.47	19.66	25.64
USOH	10000	3.9	NA	11.75	NA	NA	36.97	1000.00	1000.00	42.41	24.02	16.61	1.47	19.66	25.64
USPNW	296	3.6	82.36	NA	32.05	14.13	43.64	1000.00	1000.00	50.65	1000.00	1000.00	1.47	19.66	25.64
USSE	241	2.0	118.38	NA	NA	NA	15.95	1000.00	1000.00	18.51	1000.00	1000.00	1.47	19.66	25.64
USSPLAINS	127	1.0	133.09	18.82	18.89	NA	15.01	1000.00	1000.00	20.45	1000.00	1000.00	1.47	19.66	25.64
USWEST	296	3.4	86.71	NA	26.81	26.31	56.74	1000.00	1000.00	52.00	1000.00	1000.00	1.47	19.66	25.64
USWiscS	10000	3.7	NA	NA	26.81	26.31	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	19.66	25.64
USWiscW	10000	3.0	NA	NA	26.81	26.31	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	19.66	25.64
USWNPLAINS	126	1.3	98.51	NA	26.81	26.31	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64

*Values of 1000 indicate The at least one component of The rate was not accessible.

Table 9.5. (Continued) Comparison of Wheat Shipment Costs to China by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	55.04	47.97	50.07	130.76	123.68	125.78
USCPLAINSR	NA	44.05	46.15		93.12	95.21
USDELTA	NA	33.85	NA			
USILNorth	NA	35.07	40.16		78.94	84.03
USILSouth	NA	NA	36.33			96.33
USINNorth	NA	NA	42.88			90.37
USINRiver	NA	NA	38.92			99.96
USIowaR	NA	NA	43.70			106.51
USIowaW	NA	NA	50.88			110.97
USMI	NA	NA	41.38			
USMN	57.24	50.52	42.61	118.65	111.92	104.02
USMNR	NA	NA	46.11			126.87
USMOR	NA	NA	36.76			97.24
USMOW	NA	44.00	41.40		114.93	112.34
USNE	NA	NA	58.21			
USNPLAINS	67.11	57.55	63.31	154.31	144.75	150.51
USOH	NA	37.39	43.72			
USPNW	33.79	57.69	70.75	116.16	140.05	153.12
USSE	NA	NA	43.06			161.44
USSPLAINS	NA	44.46	42.12		177.54	175.21
USWEST	45.97	52.45	79.11	132.68	139.16	165.82
USWiscS	45.97	52.45	53.17			
USWiscW	45.97	52.45	52.96			
USWNPLAINS	45.97	52.45	NA	144.48	150.96	

Table 9.6. Comparison of Soybeans Shipment Costs to China by U.S. Production Regions.

				Rail to Export			Minimum Truck/Rail to Barge Locations +Barge to Louisiana						Barge Handle	Ocean Shipping	
ProdReg	Prod. Cost	Yield	Prod Cost	NOLA	TXGulf	PNW	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6		PNW	Gulf
	$/HA	MT/HA	$/MT						$/MT						
USCPLAINS	10000	2.3	NA	20.69	17.67	31.58	14.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USCPLAINSR	10000	2.0	NA	17.33	17.58	24.50	10.13	31.79	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USDELTA	234	2.1	111.77	9.58	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USILNorth	195	3.2	60.12	12.25	NA	27.76	11.63	18.79	35.62	13.05	22.88	25.47	1.47	19.66	25.64
USILSouth	195	2.4	79.85	11.26	NA	NA	9.22	27.30	1000.00	21.54	16.76	24.27	1.47	19.66	25.64
USINNorth	195	2.9	67.51	NA	NA	NA	10.42	28.39	1000.00	22.90	19.53	17.40	1.47	19.66	25.64
USINRiver	195	2.2	90.06	NA	NA	NA	12.01	30.74	1000.00	17.45	12.79	16.44	1.47	19.66	25.64
USIowaR	195	3.3	59.57	13.43	NA	NA	17.70	17.94	31.43	19.55	1000.00	1000.00	1.47	19.66	25.64
USIowaW	195	3.2	60.92	21.38	NA	NA	23.77	26.52	30.70	26.89	1000.00	1000.00	1.47	19.66	25.64
USMI	10000	2.6	NA	108.14	NA	NA	20.97	32.31	27.63	25.20	1000.00	26.40	1.47	19.66	25.64
USMN	177	2.6	67.32	23.47	NA	29.58	16.18	20.66	27.75	21.30	1000.00	1000.00	1.47	19.66	25.64
USMNR	195	3.2	60.89	21.97	NA	27.82	9.12	30.49	19.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USMOR	195	2.5	77.52	NA	NA	NA	9.65	18.49	1000.00	20.57	21.17	27.26	1.47	19.66	25.64
USMOW	195	2.2	88.77	15.53	27.10	31.37	14.29	28.60	1000.00	25.18	23.93	1000.00	1.47	19.66	25.64
USNE	10000	1.7	NA	NA	NA	NA	22.72	31.67	31.03	27.23	1000.00	1000.00	1.47	19.66	25.64
USNPLAINS	177	2.1	85.51	25.11	23.76	29.34	17.83	1000.00	36.20	33.72	1000.00	1000.00	1.47	19.66	25.64
USOH	10000	2.1	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	24.02	16.61	1.47	19.66	25.64
USPNW	10000	0.0	NA	NA	NA	37.86	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USSE	250	1.8	142.41	12.68	NA	34.67	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USSPLAINS	10000	1.6	NA	27.01	12.53	NA	12.55	1000.00	1000.00	17.99	1000.00	1000.00	1.47	19.66	25.64
USWEST	10000	0.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64
USWiscS	10000	2.9	NA	NA	NA	NA	1000.00	26.64	30.61	26.06	1000.00	1000.00	1.47	19.66	25.64
USWiscW	10000	3.1	NA	NA	NA	NA	1000.00	29.29	25.85	29.26	1000.00	1000.00	1.47	19.66	25.64
USWNPLAINS	177	0.0	NA	NA	NA	NA	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1.47	19.66	25.64

*Values of 1000 indicate The at least one component of The rate was not accessible.

Table 9.6. (Continued) Comparison of Soybeans Shipment Costs to China by U.S. Production Regions.

	Total Shipping Cost (Rail,Truck, Barge + Ocean)			Total Cost (Shipping +Cost of Production)		
Prod. Region	PNW	Min Rail	Min Barge	PNW	Gulf Rail	Gulf Barge
		$/MT			$/MT	
USCPLAINS	51.24	43.31	41.11			
USCPLAINSR	44.16	42.97	37.24			
USDELTA	NA	35.22	NA		146.99	
USILNorth	47.42	37.89	38.74	107.55	98.01	98.86
USILSouth	NA	36.90	36.33		116.75	116.18
USINNorth	NA	NA	37.53			105.04
USINRiver	NA	NA	39.12			129.18
USIowaR	NA	39.07	44.81		98.64	104.38
USIowaW	NA	47.02	50.88		107.94	111.80
USMI	NA	133.78	48.08			
USMN	49.24	49.11	43.29	116.57	116.43	110.62
USMNR	47.48	47.61	36.23	108.37	108.50	97.12
USMOR	NA	NA	36.76			114.28
USMOW	51.03	41.17	41.40	139.80	129.94	130.17
USNE	NA	NA	49.83			
USNPLAINS	49.00	49.40	44.94	134.51	134.91	130.45
USOH	NA	NA	43.72			
USPNW	57.52	NA	NA			
USSE	54.33	38.32	NA	196.74	180.73	
USSPLAINS	NA	38.17	39.66			
USWEST	NA	NA	NA			
USWiscS	NA	NA	53.17			
USWiscW	NA	NA	52.96			
USWNPLAINS	NA	NA	NA			

10. Empirical Model: *Spatial Grain Flows, Simulations, Calibration and Backcasting*

A large number of factors impact the distribution of world grain trade. These include supply and demand in individual countries and regions, production costs, trade and agricultural policies, interior shipping and handling costs and ocean shipping costs. To analyze these a spatial optimization model of world trade in grains was developed. Sixteen producing countries and 16 consuming countries and 31 regions were identified and selected for three crops: corn, soybeans, and wheat. Within North America there were 27 producing regions and 15 consuming regions, conforming with traditional production/consumption regions. Agronomic and consumption were estimated econometrically and are described first. Then we describe the spatial optimization model and data sources.

10.1 Harvested Area, Yields Domestic and Import Demand

Harvested area were obtained for the 3 crops in 44 countries/regions and 27 within North America and are specified as a function of a trend which represents longer term changes in arable land for each grain in individual countries and regions. This was used as a constraint in the empirical model described below. Changes in arable land may be due to changes in economic conditions and availability of water for agricultural production and trade environments. Harvested area is specified as:

$$HA_{ci} = \gamma_{0ci} + \gamma_{1ci}Trend + \epsilon_{cit}$$

where c = 1 to 44 and represents producing regions, and i = 1 to 3 and represents crop. The model is estimated with time series data of HA from 1980 to 2001 and the estimated model is used to forecast HA for The 2002-2050 period. The estimated value was posed as a maximum available land for crop production in each country and region.

Yield for each crop in individual countries/regions is specified as a function of trend which represents advancement in farming technology. Since crop yields have increased at a decreasing rate in most countries, a double log functional form was used. The yield equation is specified as:

$$ln YLD_{cit} = \gamma_{0cit} + \gamma_{1ci} ln Trend + \epsilon_{cit}$$

where c = 1 to 44, i = 1 to 3, trend = 1980 to 2001. Annual data for harvested area (HA) and yield (YLD) for the years 1980- 2001 were obtained from USDA PS&D data base (U.S. Department of Agriculture, Foreign Agriculture Service) and as discussed in section 3. The estimated model was used to forecast yields of each crop from 2002-2050.

Consumption functions were estimated for the 3 crops in the 9 countries and 7 multi-country regions. These procedures and results were described in Section 2. Import demand (MD) for each crop in the countries/regions were defined as $MD_{cit} = DD_{cit} - DP_{cit}$ where DP is total production and DD is domestic consumption. The model determines the level of import demand. If MD is positive, country c is an importing country, while country c is an exporting country if MD is negative.

10.2 Spatial Optimization Model

The objective of the model is to minimize production costs of grain and oilseeds in major producing countries and marketing costs from producing regions to consuming regions, subject to meeting import demands at importing countries and regions, available supplies and production potential in each of the exporting countries and regions, and currently available shipping costs and technologies. In addition, the model includes agricultural production and export subsidies commonly used as production enhancements means in exporting countries, import tariffs as trade impediments in importing countries and other trade relations that may affect international competition.

The logic to the objective function is that it reflects what would be considered a longer-term competitive equilibrium whereby spatial flows are determined by costs, technical restrictions and other relationships. Under these conditions, trade flows of agricultural commodities would be determined by demand, production costs in exporting countries, marketing costs from exporting countries and trade interventions. In addition, yields in producing regions are included to measure efficiency in crop and oilseed production. Demand is projected and the least cost means of meeting that demand is derived. This differs from econometric models that use functional relationships to project equilibrium trade levels, but generally are incapable of capture spatial elements of competition. Given our objective is to make longer-term forecast and the greater emphasis on spatial and modal distributions, a model based on longer-term competitive equilibrium was developed.

The model is solved jointly for each of the 3 grains. Costs included in the model are direct production costs for each grain in each exporting country and region less production subsidies, interior shipping and handling cost for each grain in each exporting region less export subsidies and ocean shipping costs plus import tariffs.

The model contains 16 exporting countries and 16 importing countries with each type of grain and oilseed having different sets of exporting and importing countries. Some exporting countries are further divided into producing and consuming regions to capture the inter-dependency between the transportation system and agricultural production. Transportation modes include truck, rail and barges for inland transportation and ocean vessel for ocean transportation.

The model includes 6 reaches in the United States defined in Section 6. Four of the six reaches have delay functions described in Section 7 which reflect the possible river congestion costs which could delay flows and increases costs. The function is a nonlinear exponential function which is near flat until flows increase to a critical level. At that point the delay costs increase sharply which forces the model to shift grain shipments to either other reaches or downriver to export ports. The rail transfer system in the United States has selective constraints imposed. Details of these relationships are described in Section 7.

The objective of the model is to minimize production costs in producing regions in exporting countries and shipping costs from producing regions in exporting countries to importing countries. This objective function is defined as

$$
\begin{aligned}
W = & \sum_c \sum_i (PC_{ci} - S_i) A_{ci} + \sum_c \sum_i \sum_j t_{cij} Q_{cij} \\
& + \sum_c \sum_i \sum_w T_{ciw} Q_{ciw} + \sum_c \sum_i \sum_p T_{cip} Q_{cip} \\
& + \sum_c \sum_p \sum_q (R_{cpq} + r_q) Q_{cpq} + \sum \sum \sum (t_{cwp} + B_p) Q^w_{cwp}
\end{aligned}
$$

where
i=index for producing regions in exporting countries,
j=index for consuming regions in exporting countries,
p=index for ports in exporting countries,
q=index for ports in importing countries,
PC_{ci}=production cost of crop c in producing region i,
A_{ci}=area used to produce crop c in producing region i,
t=transportation cost per ton,
Q=quantity of grains and oilseed shipped,
S=production subsidies in the exporting country;
r=import tariffs in the importing country;
B=delay costs associated with barge shipments on each of four reaches on the Mississippi river.

The first term on the right hand side represents production costs in producing regions in exporting countries; the next two terms represent transportation costs for shipping agricultural goods from producing regions to domestic consuming regions for domestic consumption and ports for exports in exporting countries. The fourth term represents ocean shipping from ports in exporting countries to ports in importing countries. The last term represents shipment of grain and oilseeds through the River system. Production and export subsidies S_i were deducted from production costs and import tariffs r_q were added to ocean shipping costs.

The objective function is optimized subject to a set of constraints. Some of these are arable land constraints in exporting countries, demand constraints for each type of grain and oilseed in consuming regions in both exporting and importing countries. This objective function is optimized subject to the following constraints:

1) $Y_{ci} \ A_{ci} \geq \sum_{j} Q_{cij} + \sum_{p} Q_{cip}$

2) $\sum_{c} A_{ci} \leq TA_{i}$

3) $A_{ci} \geq MA_{ci}$

4) $\sum_{i} Q_{cij} \geq D_{cj}$

5) $\sum_{p} Q_{cpq} \geq MD_{cq}$

6) $\sum_{c} \sum_{i} Q_{ciw} \leq LD_{w}$

7) $\sum_{i} Q^{R}_{cip} + \sum_{w} Q^{W}_{cwp} \geq MQ_{cp}$

8) $\sum_{i} Q^{R}_{cip} + \sum_{w} Q^{W}_{cwp} = \sum_{q} Q_{cpq}$

where

y=yield per hectare in producing regions in exporting countries,
TA=total arable land in each producing regions in exporting countries,
MA=minimum land used for each crop in producing regions in exporting countries,
D=Forecasted domestic demand in consuming regions in exporting countries,
MD=forecasted import demand in importing countries,
PC=handling capacity in each port in both exporting and importing countries,
LD_w throughput capacity for grains and oilseeds at river access point W,
MQ_p in the minimum quantity of each crop shipped through each port in the U.S.,
Q^R is quantity shipped by direct rail, and
Q^W is quantity shipped by barge.

Equation 1 indicates that total grains and oilseeds produced in each producing region in exporting countries should be equal or larger than the quantities of grains and oilseeds shipped to domestic consuming regions and export ports. It is assumed that a country exports grains and oilseeds after satisfying its domestic consumption. Under this assumption, exportable surplus is total domestic production of each type of grain and oilseed minus domestic consumption of the individual crops. Equation 2 is the physical constraint of arable land in each producing region. Since total arable land is fixed in each producing region, production activities are optimized within the physical constraint of arable land. The next constraint (Equation 3) represents characteristics of production activities in each producing region in exporting countries. In general, producers in a region tend to produce certain crops due mainly to their experience in production practices, even though producing the crops is not economically optimal. To incorporate this characteristic, Equation 3 provides the minimum production constraint for each grain or oilseed.

For back-casting, the actual production levels were introduced. Since demand for grains and oilseeds is estimated to 2050 using econometric techniques, the estimated demand for grains and oilseeds in each consuming region in importing and exporting countries is introduced into the model. Equation 4 represents the domestic demand constraints in consuming regions in exporting countries. The total quantity of grains and oilseeds shipped from producing regions to consuming regions should be larger than or equal to the total quantities needed. Equation 5 represents import demand constraints in importing countries. Equation 6 represents grain and oilseed handling capacity at inner access points in the United States. Equation 7 indicates that each port in the U.S. should receive the minimum amount of grain and oilseed based on historical data. This constraint allows more realistic trade flows from the United States to importing countries based on factors which are not included in the model. The last constraint (Equation 8) is an inventory clearing constraints at ports in exporting countries. Ports in exporting countries are not allowed to carry inventories and are considered as transhipment points in exporting grains and oilseeds. Excess supply of a grain is calculated by subtracting domestic consumption from production under an assumption that carry-over stocks remain constant over time.

A base case is defined first and used for comparison with results from alternative scenarios. The base case is interpreted as that reflecting the most likely (current) scenario. The base case uses data for the 2002/03 world crops marketing year for calibrating domestic consumption and production. For back-casting, actual values are introduced to reflect historical data. In later simulations, assumptions are relaxed to evaluate alternative scenarios.

Additional Restrictions: The model was calibrated to reflect the flows that occurred during the late 1990s and early 2000's. In addition to the restrictions implied above, some selected restrictions were imposed on the model to calibrate it to current trade patterns. These are summarized in Table 10.1. These were applied in order to capture some of the peculiarities associated with world grain shipments. Most of the restrictions affect the wheat sector and relate to costs and quality differences among suppliers and importers. The purpose the restrictions are due in part that there are numerous suppliers that are much lower cost than North America. However, some importers have trenched purchasing and import practices to import from these regions mostly due to quality differences, despite that they are higher cost. An example, India (among others including the FSU) comprise a class of new and emerging exporters with lower costs of production and shipping to many Asian markets. Similarly, Australia and Argentina are lower cost producers than North America to many regions. To capture these, we imposed restrictions of varying types to calibrate historical trade flows.

Tables 10.2 and 10.3 indicate the maintained assumptions for the base case, backcaste and sensitivities.

Projection Methodology: The model was ultimately used to make projections. To do so, the following logic was used and applied and summarized as:

- Demand is projected for each country and region based on income and population projections from Global Insights;

- Yield and production costs for each producing region are derived;

- Production potential is determined in each country/region subject to the area restriction;

- US modal rates were derived using the 2002 data and/or functional relationships; projections for missing values were from regression for each flow.

- Ocean shipping costs were projected based on oil, trend etc.

Using these, the model was solved for each year in the projection horizon. The model determines the quantity produced in each country and region, import demand, and trade flows from origins to destinations. The latter are derived for US domestic origins, as well as all international trade flow.

Table 10.1 Constraints Imposed on Model: Market and Trade Policy Restrictions

Exporter	Importer	Grain	Restriction	Reason	Impact	Duration
US	Cuba	All grains	No trade	Trade policy restriction	Maintained assumption. Rice is imported from China	Relaxed in 2005 forward
US Ethanol	none	corn	none	Accelerated expansion. Reduced exportable supplies concentrated in western regions	Exports favored from eastern regions through US Gulf to Asia, versus US PNW	Commencing in base case with existing production; expanding in 2010
US West Coast	China	Wheat	Not allowed	TCK Smut	Forces China wheat to US Gulf–relax in 2005	Relaxed in 2005 forward
US/Canada Eest Coast	EU	Wheat	Only allowed HRS from T. Bay and Duluth based on historical shares	Quality requirements	Disallows Gulf shipments	Maintained
US/Canada West Coast	Japan ,Korea, Philippines, Singapore, Thailand	Wheat	Only allowed from HRS and White Wheat regions. Based on historical shares	Quality requirements	Disallows Gulf to these Asian markets at lower cost	Maintained
Australia	Japan ,Korea, Philippines, Singapore, Thailand	Wheat	Max shipments only allowed at recent values	Quality requirements	Forces hard wheats from N. America. No direct impact on Canal	Maintained
Argentina, India, E. Europe	Japan ,Korea, Philippines, Singapore, Thailand	Wheat	No shipments allowed	Quality requirements	Forces hard wheats from N. America. No direct impact on Canal	Maintained
China	Korea	Corn	Imports of 3 mmt	Reflect recent trade	Reduce exports from US Gulf/Canal	Maintained

Table 10.2 Summary of Assumptions by Simulation

Assumption	***Scenario/Shorter Term Adjustments***			***Longer-Term***		
	Base	Backcaste	Sensitivities	Projections 1 W/out expansions	Projections 2 W/expansions	Projections 3 W/out expansions
Farm subsidies, tariffs/taxes etc	Maintained	Maintained	Maintained except 1	Maintained	Maintained	Eliminated
Actual production, consumption and export level (not by port)	Maintained	Maintained; and, actual country export level	Maintained selectively	Relaxed	Relaxed	Relaxed
Land restriction	100%area	100% area				
Brazil transport projects adopted	No	No	No	Yes	Yes	Yes
Wheat quality requirements/assumptions	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained
River expansions	Not allowed	Not allowed	Allowed	Not allowed	Allowed	Not allowed
Rail/elevator unload constraints: Rch 1 and Gulf	Maintained	Maintained	Allowed	Maintained	Maintained	Maintained
Panama expansion	Excluded	Excluded	Excluded/ except 1	Maintained	Maintained	Maintained

Sensitivities: include evaluations of ethanol, changes in Brazil, China revaluation of Yuan, Panama expansion, expansion of the river system, and impacts of modal rate spreads,
Projections: are in 10 year increments for 50 years forward;
Backcaste: Variables that change by year are: production, consumption, modal rates.

Table 10.3 Sensitivities: Summary of assumptions 2002 base case is maintained model

Assumption	***Scenario***	***Trade Policies***			***Logistical Analysis***				
	Base	Free Trade	China: Changes in Demand	Brazil N	Panama	Barge: Logistical restrict.	Expand Capacity	Barge: Changes in Rates	Ocean Spreads
Farm subsidies, tariffs/taxes etc	Maintained	Set=0	X	X	X	X	X	X	X
Actual production, consumption and export level (not by port)	Maintained	X	X	X	X	X	X	X	X
Land restriction	100%area	X	X	X	X	X	X	X	X
Brazil transport projects adopted	No	X	X	Changed	X	X	X	X	X
Wheat quality requirements/assumptions	Maintained	X	X	X	X	X	X	X	X
River expansions	Not allowed	X	X	X	X	X	Changed	X	X
Rail/elevator unload constraints: Rch 1 and Gulf	Maintained	X	X	X	X	Changed	X	X	X
Panama expansion	Excluded	X	X	X	Changed	X	X	X	X

Sensitivities: include evaluations of ethanol, changes in Brazil, China revaluation of Yuan, Panama expansion, expansion of the river system, and impacts of modal rate spreads, Projections: are in 10 year increments for 50 years forward;

11. Stochastic Modeling

11.1 Introduction/overview

The model objective function is specified as the sum of expected production costs, transportation costs, and expected delay costs. Model constraints include satisfaction of demands, acreage limits, exports limited to production, and capacity constraints of the various river reaches/segments.

Many of the model constraints involve stochastic variables. In particular, the right-hand sides of the constraints are random variables. Total shipments to a region/country are constrained to be greater than or equal to import demand which is a random variable. To account for right-hand side uncertainty, Charnes and Cooper (1959) proposed chanced-constrained programming. Assuming that a decision maker is willing to allow constraint violations with some specified probability, α, the model constraints are written as, for example,

$$\text{Prob(total shipments} \geq \text{import demand)} \geq \alpha.$$

If the distribution of import demand is known, it is possible to write the chance constraint using a linear equation.

With multiple constraints, the joint probability of satisfying all constraints simultaneously must be computed. The challenge is that few distributions allow for analytical computation of the joint cumulative density. Multiple chance constraints are usually solved by analytical computation of the joint cumulative density function (cdf). The difficulty here is that the distributions for most of the model's random variables are derived from error terms of econometric estimations. Error terms are generally distributed as normal. No closed-form expression exists for the normal cdf. These were approximated using triangular distributions. The triangular distribution has a closed-form integral, reasonably approximates the normal distribution and can be uniquely determined by a mean and variance (assuming symmetry).

11.2 Model Specification

The model determines the least-cost method for satisfying demands. The objective function considers the sum of production costs, transportation costs–truck, rail, barge and ocean–and delay costs associated with barge transport . Mathematically,

$$
\begin{aligned}
TC = & \sum_g \sum_p prod\ cost_{gp} \cdot A_{gp} \\
& + \sum_g \sum_p \sum_c Q_{gpc} \cdot trucking_{gpc} \\
& + \sum_g \sum_p \sum_r Q_{gpr} \cdot domrail\ \ rate_{gpr} \\
& + \sum_g \sum_p \sum_e Q_{gpe} \cdot exprail\ \ rate_{gpe} \\
& + \sum_g \sum_r \sum_e Q_{gre} \cdot barge\ \ rate_{gre} \\
& + \sum_g \sum_e \sum_m Q_{gem} \cdot ocean\ \ rate_{gem} \\
& + \sum_g \sum_p \sum_e Q_{gpe} \cdot trucking_{gpe} \\
& + \sum_g \sum_p \sum_c Q_{gpc} \cdot trucking_{gpc} \\
& + \sum_r \hat{Q}_r \cdot delay\ \ rate_r \ .
\end{aligned}
$$

Subscript g indicates grain, subscript p indicates producing region, subscript c indicates consuming region, subscript r indicates reach, subscript e indicates export location, and subscript m indication import location. Production costs are $prod\ cost_{gp}$, and vary by grain, production region and year. Area harvested in hectares, A_{gp}, is a choice variable of the model. Quantities of grain shipped are given by Q with subscripts to indicate grain, origination and destination. Trucking costs are reported in Appendix 6. All other transportation and delay rates are estimated. The functional forms for these rate functions are given below and parameter estimates are reported in Tables 11.1-11.4.

Barge rates:

Barge $rate_{gre}$ = $Intercept_{gre}$ + a_{gre} total barge volume + b_{gre} reach1 dummy + c_{gre} reach2 dummy + d_{gre} reach3 dummy + e_{gre} reach4 dummy + f_{gre} reach6 dummy + g_{gre} *spread*

Ocean rates:

Ocean $rate_{gem}$ = $Intercept_{gem}$ + a_{gem} ship $size_{em}$ + b_{gem} oil price + c_{gem} origin $dummy_{ge}$ + d_{gem} destination $dummy_{g\,m}$ + e_{gem} log(year) + f_{gem} log($distance_{em}$)

Domestic rail rates:

Domrail $rate_{gpc}$ = $Intercept_{gpc}$ + a_{gpc} total $distance_{pc}$ + b_{gpc} (total $distance_{gpc})^2$ + c_{gpc} distance to $barge_{pc}$ + d_{gpc} log(trend) + e_{gpc} barge rate for reach 1

Export rail rates:

Exprail $rate_{gpe}$ = $Intercept_{gpe}$ + a_{gpe} total $distance_{pe}$ + b_{gpe} (total $distance_{gpe})^2$ + c_{gpe} distance to $barge_{pe}$ + d_{gpe} log(trend) + e_{gpe} barge rate for reach 1

Delay costs:

delay $\text{cost}_r = a_{gem}\ \hat{Q}_r^{b_r}$ where

$$\hat{Q}_r = \begin{cases} \sum_g \sum_e Q_{ger} - threshold_r & if\ Q_{ger} > threshold_r \\ 0 & otherwise \end{cases}$$

For each reach, a volume threshold determines the maximum volume possible before significant delays are realized. Based on simulation results, provide by the IWR, we estimated the delay costs and the threshold for each reach.

Additionally, several constraints are imposed. Balance constraints are imposed on all origins and destinations to insure that total inflows to a location equal total outflows from that location.

Chance constraints are imposed to insure that demands are satisfied with probability α_{gc} where $0.5 \leq \alpha_{gc} \leq 1$. Forecast variances are determined for each point in time, 2000, 2010, 2020, 2030, 2040, and 2050. Forecast variance is computed as (Greene, 1997, pg. 369):

$$Var[\epsilon^0] = \sigma^2 + x^{0\prime}[\sigma^2 (X'X)^{-1}] x^0$$

We assume that the errors from the grain demand equation estimations are distributed with mean zero and are contemporaneously uncorrelated. Residuals are assumed to be normally distributed, however we use triangular distributions to approximate these distributions as the triangular density function is integrable.

Let D_{ij} denote average demand by region i for grain j and ϵ_{ij} denote random error around the mean demand. Let Q_{gc} denote quantity of grain g transported (and consumed) to region c. Then, using chance constrained programming, we assure that, with probability α_{gc}, the quantity transported is great than or equal to the quantity demanded, or $\text{Prob}(\epsilon_{gc} \leq Q_{gc} - D_{gc}) \geq \alpha_{gc}$.

Assuming symmetrically distributed error terms with zero mean and using the triangular approximations, the probability density functions of the errors terms can be express as:

$$
11.1)\quad f(\varepsilon_{gc}) = \begin{cases} \dfrac{(\varepsilon_{gc} + b_{gc})}{b_{ij}^2} if \quad -b_{gc} \le \varepsilon_{gc} \le 0; \\ \dfrac{(b_{gc} - \varepsilon_{gc})}{b_{gc}^2} if \quad 0 < \varepsilon_{gc} \le b_{gc}; \\ 0 \quad otherwise \end{cases}
$$

where ($-b_{gc}$, b_{gc}) is the domain of the positive support (see Figure 11.1 below). b_{gc} can be solved for as a function of the variance of the error term. Since we are concerned with the left tail of the distribution (as we want to the probability of positive errors to be small), we focus on the half of the density function to the left of the origin.

Integrating the density function from $-b_{gc}$ to Q_{gc}-D_{gc} yields the probability that the error term is less than or equal to Q_{gc}-D_{gc}. Or, Prob($\epsilon_{gc} \le Q_{gc}-D_{gc}$) =

$$
11.2) \int_{-b_{gc}}^{Q_{gc}-D_{gc}} f(\varepsilon_{gc}) d\varepsilon_{gc} = \frac{(Q_{gc} - D_{gc} + b_{gc})^2}{2b_{gc}^2}.
$$

We then constrained the right-hand-side of (11.2) to be greater than or equal to alpha, our confidence level:

$$
11.3)\quad \frac{(Q_{gc} - D_{gc} + b_{gc})^2}{2b_{gc}^2} \ge \alpha_{gc}.
$$

Using the quadratic formula, we solve(11.3) for the level of consumption, Q_{gc}^* that satisfies the chance constraint:

$$
11.4)\quad Q_{gc}^* \ge D_{gc} - b_{gc} + \sqrt{2b_{gc}^2 \alpha_{gc}}
$$

Equation (11.1), when imposed as a constraint, assures that Prob($\epsilon_{gc} \le Q_{gc}-D_{gc}$) $\ge \alpha_{gc}$. As the required level of confidence increases, the quantity consumed also increases. This implies that our cost estimates are conservative compared to a deterministic model.

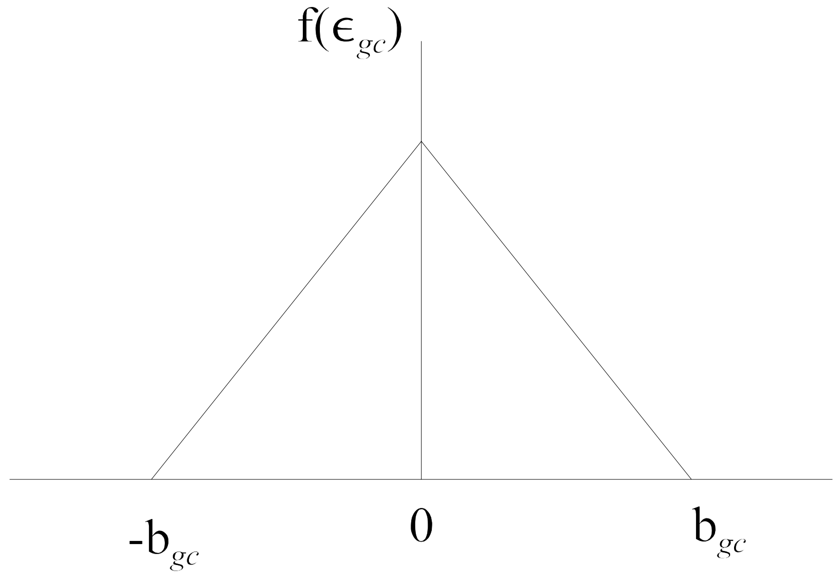

Figure 11.1 Triangular Density Function

Constraints are imposed to require that production of each grain in a region is equal to or greater than its total shipments of each grain to consuming regions, reaches, and export port by truck, barge, and rail. Total hectares planted, summed across grains, is constrained to be less than or equal to the total land area available for production.

Each producing region is required to plant at least 90% of its historical production area. This constraint is imposed to prevent the model from choosing to eliminate plantings in a region. Since the model has a least-cost objective function, the model might choose zero hectares planted in a region that traditionally plants a grain. This is highly unlikely. If a region is at a cost disadvantage for its predominant grain(s), prices of fixed factors, such as land, will adjust to assure that land is planted.

Constraints are imposed to require that certain consuming regions purchase sufficient quantities of high quality US and Canada wheat. Europe, Japan, China, S. Korea, S. Asia and SE Asia are required to purchase a minimum amount North American wheat, as percent of total wheat consumed, based on historical averages. These percentages are 2.580% for Europe, 42.574% for Japan, 17.712% for S. Korea, 13.046% for China, 36.075% for SE Asia and 1.006% for S. Asia. Finally, a constraint limits US exports through the St. Lawrence Sea Way to reflect season limitations on Great Lakes-St. Lawrence shipping. No more than 4 million MT is allowed to be shipped through US east coast ports.

The model determines the least-cost method for satisfying demands. The objective function considers the sum of production costs, transportation costs–truck, rail, barge and ocean–and delay costs associated with barge transport. Various levels of α were imposed and the minimum expected cost determined for the projection period. It is anticipated that in nearby time periods the model will be feasible for a wider range of α than for more distant time periods. This is due to increasing prediction error. As the time periods are more distant, the ability to accurate forecast stochastic variables declines, i.e., the variances increase, making it less likely that a feasible solution can be found with a high degree of certainty (α).

11.4 Modal Rate Functions

An important feature of this analysis is the modal rate functions. We evaluated several regression models with our data to determine that which most closely captures intermodal relationships.

We initially sought to define supply and demand funcitons for each model. We were not able to estimate supply and demand functions for rail and barge. In the experimentation, we extended the data, estimated them independently and jointly, used 3sls, and seemingly unrelated regressions, amongst others. We frequently got insignificant or incorrect signs on the price variable. Upon reviewing other studies, their findings are similar. In retrospection, we likely had too short of time series and some of these modes were simultaneous. However, there were two outstanding issues. For rail, given it is an oligopoly as here (if not a duopoly), a supply function as conventionally thought of in perfectly competitive industries does not exist. Rather, railroads choose their rates to maximize profits and may choose to undersupply some movements (e.g. to St. Louis, or US Gulf) in order to benefit others (e.g., Portland). Second, our optimization model determines the demand for modes which are assumed perfectly substitutable.

These were estimated using the data described above. However, the data for each mode came from varying sources that resulted in non-synchronous periods, durations, were unbalanced, and were not in anyway reported simultaneously. Hence, it was not possible to estimate these as a simultaneous set of equations which would be ideal. To do so would have resulted in data aggregations what would result in unacceptably small number of observations.

Ultimately, the regressions that were used should be interpreted as the reduced form equation for each mode and estimated separately for each model from varying sources of pooled data. The logic of the resulting specifications is that

1) rail vs barge or truck/barge are perfect substitutes;

2) barge rates respond to increases in exports (increase rates) and, to changes in fuel costs through the impact of the ocean spread; barge spreads also adjust geographically;

3) rail rates adjust geographically and behaviorally (depending on distance, distance from barges, barge rates etc) and importantly experience longer term increases in productivity resulting in lower rates and

4) ocean rates depend on distance, fuel costs, and a series of origin/destination dummy

variables.

Spatial relationships are critical and as expected. The specification ties rail rates to barge rates, but, also captures the impact of geography. Also, high barge rates from Reach 1 reduces rail rates. Thus, it captures the geographical impact as well as the impact of barge rates, and the barge rate differentials to St. Louis and the upper river origins.

The resulting equations are shown in Table 11.1-11.5.

Table 11.1 Ocean Rate Equation	
Intercept	4.01692
Ship Size (MT)	-0.5544 (-57.01)
Ocean Miles	0.4547557 (41.57)
Crude Oil Prices ($/barrel)	0.2409747 (10.33)
Binary for Origin = East Coast	0.0442165 (1.23)
Binary for Origin = Europe	0.037153 (1.00)
Binary for Origin = FSU-ME	-0.163897 (-3.35)
Binary for Origin = US Gulf	0.1265861 (3.84)
Binary for Origin = US PNW	0.0257501 (0.72)
Binary for Origin = Brazil	0.0339989 (0.99)
Binary for Destination = Central America	0.1058925 (5.05)
Binary for Destination = South America	0.2276558 (8.62)
Binary for Destination = China	0.0349367 (2.60)
Binary for Destination = S.E. Asia	0.1009639 (4.20)
Trend	-0.00242 (-1.22)
R2	.42

* T values in ( ).

Table 11.2. Average Ship Size (MT) for Ocean Movements

	Arg.	Aust.	Brazil N	Brazil S	Can East	Can West	China	Europe	Japan	South Korea	Latin Am	FSU-ME	Mexico	North Africa	Other Africa	South Asia	SE Asia	US E.C.	US Gulf	US PNW
Arg.	20858	32812	20858	20858	25000	25839	44863	34249	44863	44863	25839	27467	21081	20858	33969	44863	44863	25000	21081	25839
Aust.	32812	36750	32812	32812	48350	35851	52000	25000	52000	52000	35851	45357	40188	32812	33535	52000	52000	48350	40188	35851
Brazil N	20858	32812	20858	20858	25000	25839	44863	34249	44863	44863	25839	27467	21081	20858	33969	44863	44863	25000	21081	25839
Brazil S	20858	32812	20858	20858	25000	25839	44863	34249	44863	44863	25839	27467	21081	20858	33969	44863	44863	25000	21081	25839
Can East	22402	48350	22402	22402		20039	51125	40706	51125	51125	20039	24796	19203	22402	46381	51125	51125		19203	20039
Can West	27944	35851	27944	27944	20039	26552	53012	50188	53012	53012	26552	31912	20813	27944	37534	53012	53012	20039	20813	26552
China	44863	30000	44863	44863	51125	53012	35000	46256	35000	35000	53012	47771	52240	44863	26722	35000	35000	51125	52240	53012
Europe	22700	32490	22700	22700	40706	27250	46256	19310	46256	46256	27250	23808	23786	22700	35410	46256	46256	40706	23786	27250
Japan	44863	30000	44863	44863	51125	53012	35000	46256	35000	35000	53012	47771	52240	44863	26722	35000	35000	51125	52240	53012
S. Korea	44863	30000	44863	44863	51125	53012	35000	46256	35000	35000	53012	47771	52240	44863	26722	35000	35000	51125	52240	53012
Latin Am	27944	35851	27944	27944	20039	26552	53012	50188	53012	53012	26552	31912	20813	27944	37534	53012	53012	20039	20813	26552
FSU-ME	27467	35000	27467	27467	24796	31912	47771	28847	47771	47771	31912	19408	38507	27467	32166	47771	47771	24796	38507	31912
Mexico	17904	40188	17904	17904	19203	22982	52240	43980	52240	52240	22982	38507	18406	17904	33912	52240	52240	19203	18406	22982
N. Africa	20858	32812	20858	20858	25000	25839	44863	34249	44863	44863	25839	27467	21081	20858	33969	44863	44863	25000	21081	25839
Oth Africa	33969	23500	33969	33969	46381	35000	26722	35410	26722	26722	35000	14333	24000	33969	23503	26722	26722	46381	24000	35000
S. Asia	44863	30000	44863	44863	51125	53012	35000	46256	35000	35000	53012	47771	52240	44863	26722	35000	35000	51125	52240	53012
SE Asia	44863	30000	44863	44863	51125	53012	35000	46256	35000	35000	53012	47771	52240	44863	26722	35000	35000	51125	52240	53012
US E.C.	22402	48350	22402	22402		20039	51125	40706	51125	51125	20039	24796	19203	22402	46381	51125	51125		19203	20039
US Gulf	17904	40188	17904	17904	19203	22982	52240	43980	52240	52240	22982	38507	18406	17904	33912	52240	52240	19203	18406	22982
US PNW	27944	35851	27944	27944	20039	26552	53012	50188	53012	53012	26552	31912	20813	27944	37534	53012	53012	20039	20813	26552

Table 11.3. Barge Rate Equation	
Intercept	1.32156 (0.34)
Barge Volume (Sum of Reaches 1-6)	0.00008837 (1.07)
Real Ocean Spread (USGulf - PNW to China/Japan)	0.14867 (2.55)
Binary for Reach 2	4.60047 (5.65)
Binary for Reach 3	8.41987 (10.35)
Binary for Reach 4	3.30765 (4.06)
Binary for Reach 6	1.69886 (2.09)
R2	.72

Table 11.4. Domestic Rail Rate Equations by Grain			
	Corn	Soybean	Wheat
Intercept	9.91191 (7.90)	4.89067 (2.01)	11.57008 (2.74)
Total Distance	0.12927 (22.99)	0.01890 (11.48)	0.02225 (7.00)
Total Distance^2	-0.00000111 (-2.72)	-0.00000107 (-1.24)	-0.0000009319 (-0.64)
Distance to Nearest Barge	0.00303 (5.61)	0.00536 (3.95)	-0.00217 (-1.68)
ln(trend)	-2.40996 (-8.31)	-1.30068 (-2.27)	-.81842 (-0.84)
Real Barge Rate for Reach 1	-.40492 (-2.66)	0.03652 (0.12)	-0.65373 (-1.31)
RMSE	4.04063	6.60840	13.34827
R2	.84	.66	.39

* T values in ( ).

Table 11.5. Export Rail Rate Equations by Grain			
	Corn	Soybean	Wheat
Intercept	8.78538 (4.93)	5.92634 (2.58)	9.16013 (3.92)
Total Distance	0.02364 (19.03)	0.02099 (15.03)	0.02131 (12.61)
Total Distance^2	-0.0000046 (-7.35)	-0.00000388 (-5.94)	-0.00000247 (-3.30)
Distance to Nearest Barge	0.00250 (2.75)	0.00401 (3.43)	0.00414 (5.06)
ln(trend)	-0.58492 (-2.70)	-0.26494 (-0.95)	-0.42928 (-1.52)
Real Barge Rate for Reach 1	-1.74439 (-4.23)	-0.49251 (-0.93)	-1.21516 (-2.24)
RMSE	4.81794	6.02093	7.12364
R2	.78	.65	.68

* T values in ( ).

12. Detailed Results from the Analytical Models

Table 12.1 Exports from Port Areas by Year (backcaste Results).

	1995	1996	1997	1998	1999	2000	2001	2002
All Crops				----(1000 MT)-----				
US E. Coast	3,998	4,734	4,616	4,299	5,591	4,040	2,659	2,147
US Gulf	89,611	75,732	70,699	82,156	77,752	86,976	86,559	75,445
US PNW	19,866	16,557	14,974	14,304	21,955	14,304	14,304	14,304
Total US	113,475	97,022	90,289	100,759	105,298	105,320	103,522	91,896
Argentina	8,121	13,041	15,342	9,131	13,757	16,733	9,187	22,797
Australia	8,288	17,650	3,847	17,017	19,654	17,041	18,465	20,152
Brazil N	0	0	0	0	0	3,502	3,487	3,548
Brazil S	20	2,183	82	6,824	4,546	10,128	11,803	7,533
Canada	512	512	908	5,287	9,619	5,363	708	16,455
China	0	0	0	0	0	0	0	0
Europe	52,805	57,152	66,009	57,486	56,914	45,107	51,557	34,124
FSU-ME	0	0	1544.36	0	0	0	0	0
Latin Am.	1,977	1,068	2,057	3,609	3,281	3,738	3,784	3,836
S. Africa	52	1,906	1,592	1,527	1,888	9,975	6,250	6,468
World	185,250	190,535	181,670	201,641	214,957	216,907	208,762	206,810
Corn								
US E. Coast	0	0	0	0	0	0	0	0
US Gulf	51,577	40,643	33,202	45,389	44,179	44,301	43,371	35,322
US PNW	5,012	5,012	5,012	5,012	5,012	5,012	5,012	5,012
Total US	56,589	45,655	38,214	50,401	49,191	49,313	48,383	40,334
Argentina	8,121	13,041	15,342	8,663	13,757	12,370	9,187	11,385
Australia	51	61	42	77	59	117	165	119
Brazil N	0	0	0	0	0	3,502	499	1,198
Brazil S	20	2,183	82	1,415	1,147	6,939	2,646	3,285
Canada	0	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0	0
Europe	27,259	32,476	40,323	28,816	37,373	21,421	33,841	17,654
FSU-ME	0	0	1544.36	0	0	0	0	0
Latin Am.	0	0	0	0	0	0	0	0
S. Africa	52	1,906	1,592	1,527	1,888	1,932	1,450	1,335
World	92,092	95,323	97,138	90,900	103,414	95,595	96,171	75,311

Table 12.1 (continued). Exports from Port Areas by Year (Backcaste Results).

	1995	1996	1997	1998	1999	2000	2001	2002
Soybean				----(1000 MT)-----				
US E. Coast	0	921	0	0	0	0	0	0
US Gulf	15,876	19,267	21,420	20,228	24,867	25,433	27,278	26,753
US PNW	7,232	3,923	2,340	1,670	1,670	1,670	1,670	1,670
Total US	23,108	24,110	23,760	21,898	26,537	27,103	28,948	28,423
Argentina	0	0	0	468	0	4,363	0	4,158
Australia	0	0	0	0	0	0	0	0
Brazil N	0	0	0	0	0	0	2,988	2,350
Brazil S	0	0	0	5,409	3,399	3,189	9,157	4,249
Canada	0	0	396	987	494	475	0	3,411
China	0	0	0	0	0	0	0	0
Europe	0	0	0	0	0	0	0	0
FSU-ME	0	0	0	0	0	0	0	0
Latin Am.	1,977	1,068	2,057	3,609	3,281	3,738	3,784	3,836
S. Africa	0	0	0	0	0	0	0	884
World	25,085	25,178	26,213	32,371	33,710	38,868	44,876	47,310
Wheat								
US E. Coast	3,998	3,813	4,616	4,299	5,591	4,040	2,659	2,147
US Gulf	22,158	15,822	16,077	16,539	8,706	17,242	15,910	13,370
US PNW	7,622	7,622	7,622	7,622	15,273	7,622	7,622	7,622
Total US	33,778	27,257	28,315	28,460	29,570	28,904	26,191	23,139
Argentina	0	0	0	0	0	0	0	7,254
Australia	8,237	17,589	3,805	16,940	19,596	16,924	18,300	20,033
Brazil N	0	0	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0	0	0
Canada	512	512	512	4,300	9,126	4,888	708	13,044
China	0	0	0	0	0	0	0	0
Europe	25,546	24,676	25,686	28,670	19,541	23,686	17,716	16,470
FSU-ME	0	0	0	0	0	0	0	0
Latin Am.	0	0	0	0	0	0	0	0
S. Africa	0	0	0	0	0	8,042	4,800	4,249
World	68,073	70,035	58,318	78,370	77,833	82,444	67,715	84,190

Table 12.2 Exports from Port Areas by Year (Forecast - Current Lock Capacity).

	Base Case	2010	2020	2030	2040	2050
All Crops			----(1000 MT)-----			
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	66,381	95,024	113,448	136,377	180,488	204,789
US PNW	16,639	22,546	39,409	48,551	64,947	86,624
Total US	85,167	119,718	155,003	187,076	247,582	293,560
Argentina	26,003	24,624	27,833	31,478	41,380	45,407
Australia	19,865	24,590	30,100	41,556	46,669	53,234
Brazil N	3,510	4,475	5,149	3,987	4,293	2,570
Brazil S	4,085	6,080	8,242	10,538	10,647	10,808
Canada	12,542	14,126	16,222	18,222	23,619	25,438
China	4,576	5,610	3,698	93	0	3,784
Europe	35,277	28,523	16,008	18,693	27,030	22,399
FSU-ME	0	0	0	0	0	0
Latin Am.	3,852	3,836	4,627	5,480	6,254	6,727
S. Africa	7,445	11,389	16,649	22,022	28,350	32,155
World	202,322	242,970	283,532	339,145	435,824	496,082
Corn						
US E. Coast	0	0	0	0	0	0
US Gulf	33,339	52,719	62,946	80,517	105,869	130,350
US PNW	7,347	13,254	30,117	35,129	55,655	65,310
Total US	40,686	65,973	93,062	115,645	161,524	195,660
Argentina	11,295	11,195	13,159	15,031	19,712	21,589
Australia	109	148	194	238	145	292
Brazil N	1,168	1,676	2,082	579	1,475	1,070
Brazil S	1,408	1,993	2,448	2,811	1,623	1,169
Canada	0	0	0	0	0	0
China	0	0	0	0	0	0
Europe	16,585	9,710	0	0	0	0
FSU-ME	0	0	0	0	0	0
Latin Am.	0	0	0	0	0	0
S. Africa	983	0	0	0	0	0
World	72,235	90,696	110,946	134,305	184,479	219,780

Table 12.2 (continued). Exports from Port Areas by Year (Forecast - Current Lock Capacity).

	Base Case	2010	2020	2030	2040	2050
Soybean			----(1000 MT)-----			
US E. Coast	0	0	0	0	0	0
US Gulf	32,408	40,598	48,826	53,462	67,163	68,657
US PNW	1,670	1,670	1,670	5,801	1,670	13,692
Total US	34,078	42,268	50,496	59,263	68,833	82,348
Argentina	3,876	844	109	0	0	0
Australia	0	0	0	0	0	0
Brazil N	2,342	2,799	3,067	3,408	2,818	1,500
Brazil S	2,676	4,087	5,794	7,727	9,024	9,639
Canada	1,179	785	781	768	656	431
China	0	0	0	0	0	0
Europe	0	0	0	0	0	0
FSU-ME	0	0	0	0	0	0
Latin Am.	3,852	3,836	4,627	5,480	6,254	6,727
S. Africa	299	185	28	0	0	0
World	48,302	54,804	64,901	76,646	87,586	100,645
Wheat						
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	634	1,707	1,676	2,399	7,455	5,783
US PNW	7,622	7,622	7,622	7,622	7,622	7,622
Total US	10,403	11,476	11,445	12,168	17,224	15,552
Argentina	10,832	12,585	14,566	16,447	21,667	23,818
Australia	19,756	24,442	29,906	41,318	46,524	52,941
Brazil N	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0
Canada	11,364	13,341	15,441	17,454	22,963	25,008
China	4,576	5,610	3,698	93	0	3,784
Europe	18,692	18,813	16,008	18,693	27,030	22,399
FSU-ME	0	0	0	0	0	0
Latin Am.	0	0	0	0	0	0
S. Africa	6,163	11,204	16,621	22,022	28,350	32,155
World	81,785	97,471	107,684	128,195	163,759	175,658

Table 12.3 Exports from Port Areas by Year (Forecast - Expanded Lock Capacity).

	Base Case	2010	2020	2030	2040	2050
All Crops			----(1000 MT)-----			
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	66,381	96,296	128,395	150,635	182,906	222,839
US PNW	16,639	21,275	24,461	34,768	59,977	65,980
Total US	85,167	119,718	155,003	187,550	245,030	290,967
Argentina	26,003	24,624	27,833	31,478	40,684	43,006
Australia	19,865	24,590	30,100	41,556	47,745	54,369
Brazil N	3,510	4,475	5,149	3,513	4,293	3,930
Brazil S	4,085	6,080	8,242	10,538	10,647	12,501
Canada	12,542	14,126	16,222	18,222	24,266	26,379
China	4,576	5,610	3,698	93	0	0
Europe	35,277	28,523	16,008	18,693	27,030	22,399
FSU-ME	0	0	0	0	0	0
Latin Am.	3,852	3,836	4,627	5,480	6,254	7,161
S. Africa	7,445	11,389	16,649	22,022	27,725	31,437
World	202,322	242,970	283,532	339,145	433,674	492,149
Corn						
US E. Coast	0	0	0	0	0	0
US Gulf	33,339	53,990	77,893	90,644	107,064	139,899
US PNW	7,347	11,983	15,169	25,476	50,685	55,531
Total US	40,686	65,973	93,062	116,120	157,749	195,430
Argentina	11,295	11,195	13,159	15,031	19,017	19,188
Australia	109	148	194	238	258	292
Brazil N	1,168	1,676	2,082	105	1,475	1,070
Brazil S	1,408	1,993	2,448	2,811	1,623	1,169
Canada	0	0	0	0	0	0
China	0	0	0	0	0	0
Europe	16,585	9,710	0	0	0	0
FSU-ME	0	0	0	0	0	0
Latin Am.	0	0	0	0	0	0
S. Africa	983	0	0	0	0	0
World	72,235	90,696	110,946	134,305	180,122	217,149

Table 12.3 (continued). Exports from Port Areas by Year (Forecast - Expanded Lock Capacity).

	Base Case	2010	2020	2030	2040	2050
Soybean			----(1000 MT)-----			
US E. Coast	0	0	0	0	0	0
US Gulf	32,408	40,598	48,826	57,593	68,123	76,460
US PNW	1,670	1,670	1,670	1,670	1,670	2,827
Total US	34,078	42,268	50,496	59,263	69,793	79,288
Argentina	3,876	844	109	0	0	0
Australia	0	0	0	0	0	0
Brazil N	2,342	2,799	3,067	3,408	2,818	2,860
Brazil S	2,676	4,087	5,794	7,727	9,024	11,332
Canada	1,179	785	781	768	656	622
China	0	0	0	0	0	0
Europe	0	0	0	0	0	0
FSU-ME	0	0	0	0	0	0
Latin Am.	3,852	3,836	4,627	5,480	6,254	7,161
S. Africa	299	185	28	0	0	0
World	48,302	54,804	64,901	76,646	88,545	101,264
Wheat						
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	634	1,707	1,676	2,399	7,719	6,479
US PNW	7,622	7,622	7,622	7,622	7,622	7,622
Total US	10,403	11,476	11,445	12,168	17,488	16,248
Argentina	10,832	12,585	14,566	16,447	21,667	23,818
Australia	19,756	24,442	29,906	41,318	47,487	54,077
Brazil N	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0
Canada	11,364	13,341	15,441	17,454	23,610	25,757
China	4,576	5,610	3,698	93	0	0
Europe	18,692	18,813	16,008	18,693	27,030	22,399
FSU-ME	0	0	0	0	0	0
Latin Am.	0	0	0	0	0	0
S. Africa	6,163	11,204	16,621	22,022	27,725	31,437
World	81,785	97,471	107,684	128,195	165,007	173,736

Table 12.4. Sensitivities

	Base Case	Brazil 90%	Brazil 110%	China 90%	China 110%	China 120%	EU 95%	EU 105%	ETH 90%	ETH 110%	FREE Trade	PAN
All Crops												
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	66,381	66,888	66,149	66,255	66,888	66,888	69,026	65,877	68,244	67,122	78,500	66,381
US PNW	16,639	16,639	16,639	16,639	16,639	16,639	17,146	16,639	17,020	16,765	16,639	16,639
Total US	85,167	85,673	84,935	85,041	85,673	85,673	88,319	84,662	87,411	86,034	97,286	85,167
Argentina	26,003	27,045	23,271	23,271	27,045	27,045	25,465	26,218	26,003	25,465	27,045	26,003
Australia	19,865	19,865	19,865	19,865	19,865	19,865	19,870	19,606	19,865	19,870	19,865	19,865
Brazil N	3,510	3,960	5,160	3,510	5,490	5,865	3,676	3,342	3,510	3,676	3,510	3,510
Brazil S	4,085	2,087	6,083	4,085	4,085	6,939	4,287	3,881	4,085	4,287	4,085	4,085
Canada	12,542	12,542	12,542	12,542	12,542	12,542	12,573	12,316	12,542	12,573	12,542	12,542
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	3,508	4,576	4,576	4,576	4,576
Europe	35,277	35,277	35,277	35,277	35,277	35,277	26,104	43,617	35,277	35,859	35,277	35,277
Latin Am.	3,852	3,852	3,169	3,183	3,852	3,852	3,803	3,852	3,852	3,704	3,169	3,852
S. Africa	7,445	7,445	7,445	7,445	7,445	7,743	7,596	6,400	7,445	7,596	7,445	7,445
World	202,322	202,322	202,322	198,793	205,850	209,378	196,268	207,402	204,566	203,639	214,799	202,322

Table 12.4 (continued). Sensitivities

	Base Case	Brazil 90%	Brazil 110%	China 90%	China 110%	China 120%	EU 95%	EU 105%	ETH 90%	ETH 110%	FREE Trade	PAN
<u>Corn</u>												
US E. Coast	0	0	0	0	0	0	0	0	0	0	0	0
US Gulf	33,339	33,339	33,339	33,339	33,339	33,339	35,406	33,339	35,202	33,502	36,222	33,339
US PNW	7,347	7,347	7,347	7,347	7,347	7,347	7,854	7,347	7,728	7,473	7,347	7,347
Total US	40,686	40,686	40,686	40,686	40,686	40,686	43,260	40,686	42,930	40,975	43,569	40,686
Argentina	11,295	11,295	11,295	11,295	11,295	11,295	11,433	11,295	11,295	11,433	11,295	11,295
Australia	109	109	109	109	109	109	114	109	109	114	109	109
Brazil N	1,168	1,168	1,168	1,168	1,168	1,168	1,334	1,168	1,168	1,334	1,168	1,168
Brazil S	1,408	1,408	1,408	1,408	1,408	1,408	1,611	1,408	1,408	1,611	1,408	1,408
Canada	0	0	0	0	0	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0	0	0	0	0	0
Europe	16,585	16,585	16,585	16,585	16,585	16,585	13,879	19,844	16,585	17,167	16,585	16,585
Latin Am.	0	0	0	0	0	0	0	0	0	0	0	0
S. Africa	983	983	983	983	983	983	1,135	983	983	1,135	983	983
World	72,235	72,235	72,235	72,235	72,235	72,235	72,764	75,494	74,479	73,767	75,118	72,235

Table 12.4 (continued). Sensitivities

	Base Case	Brazil 90%	Brazil 110%	China 90%	China 110%	China 120%	EU 95%	EU 105%	ETH 90%	ETH 110%	FREE Trade	PAN
Soybean												
US E. Coast	0	0	0	0	0	0	0	0	0	0	0	0
US Gulf	32,408	32,915	32,176	32,282	32,915	32,915	32,986	32,371	32,408	32,986	36,364	32,408
US PNW	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670
Total US	34,078	34,585	33,846	33,952	34,585	34,585	34,656	34,041	34,078	34,656	38,034	34,078
Argentina	3,876	4,917	1,143	1,143	4,917	4,917	3,200	4,255	3,876	3,200	4,917	3,876
Australia	0	0	0	0	0	0	0	0	0	0	0	0
Brazil N	2,342	2,792	3,992	2,342	4,322	4,697	2,342	2,174	2,342	2,342	2,342	2,342
Brazil S	2,676	678	4,674	2,676	2,676	5,531	2,676	2,472	2,676	2,676	2,676	2,676
Canada	1,179	1,179	1,179	1,179	1,179	1,179	1,209	1,179	1,179	1,209	1,179	1,179
China	0	0	0	0	0	0	0	0	0	0	0	0
Europe	0	0	0	0	0	0	0	0	0	0	0	0
Latin Am.	3,852	3,852	3,169	3,183	3,852	3,852	3,803	3,852	3,852	3,704	3,169	3,852
S. Africa	299	299	299	299	299	598	299	242	299	299	299	299
World	48,302	48,302	48,302	44,773	51,830	55,358	48,185	48,215	48,302	48,087	52,616	48,302

Table 12.4 (continued). Sensitivities

	Base Case	Brazil 90%	Brazil 110%	China 90%	China 110%	China 120%	EU 95%	EU 105%	ETH 90%	ETH 110%	FREE Trade	PAN
Wheat												
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	634	634	634	634	634	634	634	167	634	634	5,914	634
US PNW	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622
Total US	10,403	10,403	10,403	10,403	10,403	10,403	10,403	9,936	10,403	10,403	15,683	10,403
Argentina	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,667	10,832	10,832	10,832	10,832
Australia	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,497	19,756	19,756	19,756	19,756
Brazil N	0	0	0	0	0	0	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0	0	0	0	0	0	0
Canada	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,138	11,364	11,364	11,364	11,364
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	3,508	4,576	4,576	4,576	4,576
Europe	18,692	18,692	18,692	18,692	18,692	18,692	12,225	23,772	18,692	18,692	18,692	18,692
Latin Am.	0	0	0	0	0	0	0	0	0	0	0	0
S. Africa	6,163	6,163	6,163	6,163	6,163	6,163	6,163	5,175	6,163	6,163	6,163	6,163
World	81,785	81,785	81,785	81,785	81,785	81,785	75,319	83,693	81,785	81,785	87,065	81,785

Table 12.5. Sensitivities for PNW Rail Rates, Barge Rates and Barge Capacity

	Base Case	PNW +10%	PNW +20%	RCH +20	RCH +40	RCH +60	RCH +80	RCH +100	RCH +150	RCH +200	SCN 10	SCN 15	SCN 20	SCN 25	SCN 30
All Crops															
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	66,381	51,618	25,356	59,550	59,550	59,550	46,333	50,323	45,154	44,883	66,381	66,381	66,381	66,381	66,381
US PNW	16,639	31,402	57,664	23,470	23,470	23,470	36,687	32,697	38,372	38,643	16,639	16,639	16,639	16,639	16,639
Total US	85,167	85,167	85,167	85,167	85,167	85,167	85,167	85,167	85,673	85,673	85,167	85,167	85,167	85,167	85,167
Argentina	26,003	26,003	26,003	26,003	26,003	26,003	26,686	26,686	26,180	26,180	26,003	26,003	26,003	26,003	26,003
Australia	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865
Brazil N	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510
Brazil S	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085
Canada	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576
Europe	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277
Latin Am.	3,852	3,852	3,852	3,852	3,852	3,852	3,169	3,169	3,169	3,169	3,852	3,852	3,852	3,852	3,852
S. Africa	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445
World	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322

Table 12.5 (continued). Sensitivities for PNW Rail Rates, Barge Rates and Barge Capacity

	Base Case	PNW +10%	PNW +20%	RCH +20	RCH +40	RCH +60	RCH +80	RCH +100	RCH +150	RCH +200	SCN 10	SCN 15	SCN 20	SCN 25	SCN 30
Corn															
US E. Coast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Gulf	33,339	20,577	13,141	26,508	26,508	26,508	26,508	26,508	26,508	26,508	33,339	33,339	33,339	33,339	33,339
US PNW	7,347	20,109	27,544	14,178	14,178	14,178	14,178	14,178	14,178	14,178	7,347	7,347	7,347	7,347	7,347
Total US	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686
Argentina	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295
Australia	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109
Brazil N	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168
Brazil S	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Europe	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585
Latin Am.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Africa	983	983	983	983	983	983	983	983	983	983	983	983	983	983	983
World	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235

Table 12.5 (continued). Sensitivities for PNW Rail Rates, Barge Rates and Barge Capacity

	Base Case	PNW +10%	PNW +20%	RCH +20	RCH +40	RCH +60	RCH +80	RCH +100	RCH +150	RCH +200	SCN 10	SCN 15	SCN 20	SCN 25	SCN 30
Soybeans															
US E. Coast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Gulf	32,408	30,407	11,977	32,408	32,408	32,408	19,191	23,182	18,013	17,742	32,408	32,408	32,408	32,408	32,408
US PNW	1,670	3,671	22,101	1,670	1,670	1,670	14,887	10,897	16,572	16,843	1,670	1,670	1,670	1,670	1,670
Total US	34,078	34,078	34,078	34,078	34,078	34,078	34,078	34,078	34,585	34,585	34,078	34,078	34,078	34,078	34,078
Argentina	3,876	3,876	3,876	3,876	3,876	3,876	4,559	4,559	4,052	4,052	3,876	3,876	3,876	3,876	3,876
Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazil N	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342
Brazil S	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676
Canada	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179
China	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Europe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Latin Am.	3,852	3,852	3,852	3,852	3,852	3,852	3,169	3,169	3,169	3,169	3,852	3,852	3,852	3,852	3,852
S. Africa	299	299	299	299	299	299	299	299	299	299	299	299	299	299	299
World	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302

Table 12.5 (continued). Sensitivities for PNW Rail Rates, Barge Rates and Barge Capacity

	Base Case	PNW +10%	PNW +20%	RCH +20	RCH +40	RCH +60	RCH +80	RCH +100	RCH +150	RCH +200	SCN 10	SCN 15	SCN 20	SCN 25	SCN 30
Wheat															
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	634	634	238	634	634	634	634	634	634	634	634	634	634	634	634
US PNW	7,622	7,622	8,018	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622
Total US	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403
Argentina	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832
Australia	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756
Brazil N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576
Europe	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692
Latin Am.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Africa	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163
World	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785

Table 12.6. Sensitivities of Rail Unload Capacity, Production Cost, EU Corn,

	Base Case	NO 08	NO 10	NO 12	NO 14	NO 16	NO 18	Z2Cap	PNW 20L	Prod Cost Zero	EU Corn 2010
All Crops											
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	66,381	66,381	66,381	66,381	66,381	66,381	66,381	66,381	53,020	66,777	95,024
US PNW	16,639	16,639	16,639	16,639	16,639	16,639	16,639	16,639	30,000	16,639	18,693
Total US	85,167	85,167	85,167	85,167	85,167	85,167	85,167	85,167	85,167	85,563	115,865
Argentina	26,003	26,003	26,003	26,003	26,003	26,003	26,003	26,003	26,003	23,271	24,624
Australia	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	19,865	24,590
Brazil N	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	3,510	4,475
Brazil S	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	4,085	5,812	6,080
Canada	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	12,542	14,126
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	5,610
Europe	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	35,277	32,376
Latin Am.	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,836
S. Africa	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	7,445	8,020	11,389
World	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,322	202,289	242,970

Table 12.6 (continued). Sensitivities of Rail Unload Capacity, Production Cost, EU Corn,

	Base Case	NO 08	NO 10	NO 12	NO 14	NO 16	NO 18	Z2Cap	PNW 20L	Prod Cost Zero	EU Corn 2010
Corn											
US E. Coast	0	0	0	0	0	0	0	0	0	0	0
US Gulf	33,339	33,339	33,339	33,339	33,339	33,339	33,339	33,339	19,978	33,339	52,719
US PNW	7,347	7,347	7,347	7,347	7,347	7,347	7,347	7,347	20,708	7,347	9,401
Total US	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	40,686	62,120
Argentina	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,295	11,195
Australia	109	109	109	109	109	109	109	109	109	109	148
Brazil N	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,168	1,676
Brazil S	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,408	1,993
Canada	0	0	0	0	0	0	0	0	0	0	0
China	0	0	0	0	0	0	0	0	0	0	0
Europe	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	16,585	13,564
Latin Am.	0	0	0	0	0	0	0	0	0	0	0
S. Africa	983	983	983	983	983	983	983	983	983	983	0
World	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	72,235	90,696

Table 12.6 (continued). Sensitivities of Rail Unload Capacity, Production Cost, EU Corn,

	Base Case	NO 08	NO 10	NO 12	NO 14	NO 16	NO 18	Z2Cap	PNW 20L	Prod Cost Zero	EU Corn 2010
Soybeans											
US E. Coast	0	0	0	0	0	0	0	0	0	0	0
US Gulf	32,408	32,408	32,408	32,408	32,408	32,408	32,408	32,408	32,408	32,805	40,598
US PNW	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670	1,670
Total US	34,078	34,078	34,078	34,078	34,078	34,078	34,078	34,078	34,078	34,475	42,268
Argentina	3,876	3,876	3,876	3,876	3,876	3,876	3,876	3,876	3,876	1,143	844
Australia	0	0	0	0	0	0	0	0	0	0	0
Brazil N	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,342	2,799
Brazil S	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	2,676	4,404	4,087
Canada	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	785
China	0	0	0	0	0	0	0	0	0	0	0
Europe	0	0	0	0	0	0	0	0	0	0	0
Latin Am.	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,852	3,836
S. Africa	299	299	299	299	299	299	299	299	299	875	185
World	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,302	48,269	54,804

Table 12.6 (continued). Sensitivities of Rail Unload Capacity, Production Cost, EU Corn,

	Base Case	NO 8 MMT	NO 10 MMT	NO 12 MMT	NO 14 MMT	NO 16 MMT	NO 18 MMT	Z2Cap	PNW 20L	Prod Cost Zero	EU Corn 2010
Wheat											
US E. Coast	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
US Gulf	634	634	634	634	634	634	634	634	634	634	1,707
US PNW	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622	7,622
Total US	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	10,403	11,476
Argentina	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	12,585
Australia	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	19,756	24,442
Brazil N	0	0	0	0	0	0	0	0	0	0	0
Brazil S	0	0	0	0	0	0	0	0	0	0	0
Canada	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	11,364	13,341
China	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	4,576	5,610
Europe	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,692	18,813
Latin Am.	0	0	0	0	0	0	0	0	0	0	0
S. Africa	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	6,163	11,204
World	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	81,785	97,471

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