WORLD AND UNITED STATES WHEAT SUPPLY,

DEMAND, PRICES AND A PRICING MODEL

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DEMAND, PRICES AND A PRICING MODEL

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Introduction

Wheat is grown in virtually every country in the world. Nearly everyone uses food products made from wheat daily. Information about wheat supply, demand, price, and harvest calendars widely concerns farmers and analysts. This research is composed of three different studies. They provide needed information about wheat supply, demand, price, harvest calendars, and a price-estimation model.

The first study, "The World's Wheat Supply," discusses world wheat supply, demand, harvest calendar, and prices. This study presents a harvest calendar, starting in March and ending in February of the following year. The harvest calendar gives the harvest times and five-year average production from the 2004/05 through 2008/09 crops for the largest wheat producers. The wheat harvest calendar also identifies major exporting and major importing countries. Major exporters include Argentina, Australia, Canada, the EU-27, and the United States. Major importers include Brazil, China, selected Mideast countries, North Africa, Pakistan and Southeast Asia. Other countries have significant wheat production, but they are not classified as major importer or exporters. These are listed as selected others including India, Former Soviet Union (FSU-12), Russia, Kazakhstan, and Ukraine. The harvest calendar tells farmers, analysts and interested persons when, where, and how much wheat is produced.

In the supply, demand, and price section, the study lists the world five-year averages of beginning stocks and usage, incorporated with the five-year averages of US seasonal wheat prices. Data is reported as United States Department of Agriculture wheat marketing year, which starts in June and ends in May. Starting in June, supply increases until it peaks in September, and then decreases until the end of the year. From June until September, wheat prices increase with wheat supply. Wheat prices peak at supply peaks, and stay constant from October to May. With this information available, farmers, decision makers, and analysts can make their plans for when and how much to plant, buy, store, or sell wheat to maximize profit.

The second study, "World Wheat Exports, Imports, and Prices," presents overall world wheat exports, imports, and prices of different types of wheat. Wheat is categorized into eight classes: Hard Red Winter (HRW), Hard Red Spring (HRS), Soft Red Winter (SRW), Hard White, Soft White, Durum, Unclassed and Mixed Wheat (FGIS/USDA).

In the United States, Hard Red Winter wheat makes up approximately 43 percent of all U.S. wheat production; Hard Red Spring is around 19 percent, Soft Red Winter wheat near 22 percent, White Wheat about 12 percent and Durum about 4 percent.

Major exporters, including a new exporter (the Former Soviet Union countries), export about 90% of the world's wheat. During the 10-year period of 2000/01 through 2009/10, Argentina exported 8.1 percent of the world's wheat. Australia exported 11.9 percent. Canada exported 14.1 percent, the EU-27 13.6 percent and the U.S. exported 23.4 percent of the world's exported wheat.

During the last few years, a second tier of exporting countries has emerged. These include Kazakhstan, Russia, and the Ukraine of the Former Soviet Union (FSU). During the 10-year period 2000/01 through 2009/10, the Former Soviet Union countries' average percentage of world wheat exports was 18.5 percent. The FSU export percentage was 26.3 percent in 2008/09 and is projected to be 28.1 percent in 2009/10.

Major importers are mentioned above. These countries, except Brazil, are in the Eastern Hemisphere. This gives a transportation advantage for Eastern Hemisphere exporters, which could higher the wheat price at terminal market.

Hard Red Winter wheat is used primarily to make bread flour. Hard Red Spring has high protein, which is suitable for making specialty breads and blending with lower protein wheat. Flour from milling Soft Red Winter wheat is used in the United States to make cakes, cookies, and crackers. White Wheat flour is used for noodle products, crackers, cereals, and white-crusted breads. Durum is used for pasta production.

By understanding the use of different wheat classes, interested parties can adjust their decisions whether to buy/sell or store certain classes of wheat profit as production made from that wheat class changes.

The wheat prices section provides a comparison of all wheat types in the US, and US wheat prices compared to other major exporters' countries. For all US wheat, US seasonal price is the lowest price level because the price is at farm level. Minneapolis wheat has the highest price level because of its high protein. Second highest price is Louisiana Golf Port Hard Red winter wheat, following by Kansas City Hard Red Winter wheat. Second lowest price is Soft Red Louisiana Gulf Port wheat.

Regarding the price of US wheat compared to other major exporting countries, US has the lowest price because the price is at farm level. All the other prices are terminal market prices. The highest wheat prices are in Rotterdam, because they are most likely to have transportation advantages when export to Asia and Africa. The second highest prices are from Canada. Canada's high prices are likely due to producing high-protein spring wheat. Canada exports wheat to South America and Asia. Following Canada is Australia. Australia exports wheat to the Asian market. Argentina has the lowest price among other countries. All major exporters, except Argentina, have a similar seasonal price pattern as the US seasonal price. Argentina, a Southern Hemisphere country, has a different price pattern because it has a different harvest calendar.

The third study, "Rework of a Simplified Procedure to Predict Seasonal Average Wheat Price," is a revision of Anderson and Tweeten (1975). It is a simple, easy-to-use model to estimate wheat prices based on currently available information about supply and demand of wheat and

feed grains. The original study by Anderson and Tweeten (1975) used data from 1955-1973, while this study uses data from 1975-2009.

The study found that wheat utilization to ending stocks ratio has a positive relationship with wheat prices, and feed grain utilization to ending stocks ratio is insignificant in explaining wheat prices. It also found that government policies such as the more market-oriented Farm Bills during 1987-1996 and 1997-2009 were associated with lower wheat prices.

Through this model, analysts can anticipate the directional shift of wheat prices when changes in market conditions such as favorable weather, low exports, decreased wheat consumption, etc., occur. With visualized charts and handy instructions, analysts can easily use the United States Department of Agriculture reports to anticipate wheat prices.

Study 1
The World's Wheat Supply

Wheat is the "Bread of Life" and nearly every country in the world grows wheat. The only places where wheat is not grown are Antarctica, the Arctic and a few small countries in South America and Africa (Figure 1). For the wheat marketing-years (June 1 through May 31) 2004 through 2008, average world wheat production was 21.40 billion bushels.

Major world wheat producing countries (production is based on a 5-year average) include the 27 countries of the European Union (EU-27) that produces 4.9 billion bushels; China, producing 3.8 billion bushels; India, producing 2.7 billion bushels; the United States, producing 2.1 billion bushels; and Russia, producing 1.85 billion bushels. A second tier of wheat producers are Canada with average production of 922 million bushels (mb), Australia 690 mb, Pakistan 583 mb, Ukraine 490 mb, North Africa 432 mb, and Kazakhstan 368 mb.

The World Agricultural Outlook Board and the USDA reports wheat production and use categories that include World, United States, Total Foreign, Major Exporters, Major Importers and Selected Others (Figure 2). Major Exporters, Major Importers and Selected Others produce about 94 percent of the world's wheat.

Major Exporters include Argentina, Australia, Canada, the EU-27, and the United States. Major Importers include Brazil, China, Selected Mideast countries, North Africa, Pakistan and Southeast Asia. Selected Others include India, Former Soviet Union (FSU-12), Russia, Kazakhstan, and Ukraine.

Major Exporters produce 40 percent, Major Importers produce 26 percent, and Selected Others produce about 27 percent of the world's wheat production. About seven percent of the world's wheat production is produced by the remaining countries.

Data

The Foreign Agriculture Service, USDA, maintains a data set for agricultural commodities, by world, region, and country (http://www.fas.usda.gov/psdonline/psdHome.aspx). Annual production, imports, total use, exports, feed use, food use and total use by country and region were downloaded from this web site. Data was also obtained from the World Agriculture Supply and Demand Reports (USDA, World Agricultural Outlook Board).

Harvest dates were obtained from the USDA World Agricultural Outlook Board and the Joint Agricultural Weather Facility (Agricultural Handbook No. 564, September 1964).

United States Department of Agriculture (USDA) marketing-year wheat production and use is reported based on a June through May marketing year (MY). The USDA includes wheat harvested during the March through May period in India, Pakistan and North Africa as part of the following June through May marketing year's production. Since there is very little wheat harvested in January and February, world wheat production is essentially reported on a calendar year basis. Use is reported on a June through May basis.

Timing of World Wheat Harvest

Marketing-year production begins in India in March. India completes harvest in mid-May. Pakistan harvests wheat between April and mid-June. By June 1, India's, Pakistan's, Northwestern Africa's and about half of China's winter wheat has been harvested.

Both the European Union and the United States harvest from late-May through mid-September. Wheat is harvested in the FSU countries between mid-July and October 1. As of October 1, of the major wheat producing countries, only Argentina, Australia and Brazil have not harvested their wheat. About 82 percent of the world's wheat is harvested in the Northern Hemisphere and 18 percent in the Southern. Argentina, Australia and Brazil harvest about six percent of wheat world's wheat production.

Wheat Production

Estimated world wheat production and average use by month is shown in Figure 3. The five-year average (2004/05 through 2008/09) world wheat production is 23.05 billion bushels. About 24 percent of marketing-year production is harvested by June 1. By August 31, 82 percent of the world's harvest is complete. Ninety-two percent of the world's wheat harvest is complete by October 1. When Argentina starts harvesting in November, about 96 percent of the world's wheat has been harvested. Argentina produces about 2.2 percent of the world's wheat production and Australia produces about 3.5 percent of the world's wheat production.

World wheat production peaks in August (5.3 billion bushels) when about 82 percent of the harvest has been completed. By that time, winter wheat harvests have been completed in the U.S., the EU, and the FSU countries, China is completing its spring wheat harvest and Canada and the U.S. is beginning spring wheat harvest (Figure 2).

Figure 1. World Wheat Production Map

< 5 million bushels (mb)	(magenta)
5 mb – 50 mb	(yellow)
50 - 500 mb	(red)
500 mb – 2.0 billion bushels (bb)	(blue)
> 2.0 bb	(green)

Source: USDA PS&D Data Series

Figure 2. Five-Year Average Annual Production for Selected Countries and Harvest Periods: 2004/05 through 2008/09 in Billion Bushels.

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Major Exporters												
US					2.13							
Argentina										0.52		
Australia									0.69			
Canada							0.93					
EU-27					4.89							
Major Importers												
Brazil								0.17				
China			3.42		0.46							
Northwestern Africa (winter)			0.43									
Middle East				0.68								
Pakistan (winter)		0.58										
Former SU					3.47							
Russian					1.85							
Kazakhstan					0.37							
Ukraine					0.49							
India	2.68											

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Major Exporters						7.03						
Major Importers					6.19							
India	2.68											
Former SU					3.47							

Source: WASDE Major World Crop Area and Climatic profiles

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By September 30, about 92 percent of the marketing-year wheat has been harvested. Production in October is less than total monthly use. During the period October through April, Beginning Stocks decline. Beginning Stocks increase between May and August. September production is about the same as monthly use.

Wheat Use

The five-year average annual world wheat use is 22.8 billion bushels. In Figure 3 and the analysis reported, world wheat use was allocated equally over the 12-month marketing-year. Average monthly consumption was 1.9 billion bushels (22.8 ÷ 12).

Note that for this five-year period, average wheat use was lower than production and world wheat stocks increased. Between the 2004/05 and 2008/09 wheat marketing years, the minimum wheat use was 22.4 billion bushels (2004/05) and the maximum was 23.3 billion bushels (2008/09).

Wheat exports averaged 4.34 billion bushels per year or about 19 percent of the world's wheat production was exported or conversely imported. Of the 4.34 billion bushel average exports, three billion bushels (~69%) was exported by the Major Exporter. The remaining 31 percent was exported by other countries.

The United States exports about 23 percent of world wheat exports, followed by Canada with 14.4 percent, 13.6 percent by the EU, 10.2 percent by Australia and seven percent by Argentina. The FSU countries account for 11.6 percent of the world's wheat exports. Kazakhstan exports about 5.3 percent and the Ukraine exports 3.4 percent of the world's exports. Trade (exports) between countries within the EU is not accounted for in the export percentages.

Of the 22.8 billion bushel average annual use, about 3.9 billion bushels are used for feed. The remaining is used for food and industrial use.

Beginning Stocks

Beginning stocks for each month are the stocks on the first day of each month (Figure 3). Production includes all wheat produced during the month and thus, represents the last day of each month. Beginning stocks were calculated by adding monthly production to the prior months beginning stocks and then subtracting monthly use.

Figure 3. World Average Monthly Wheat Production, Use, Supply, and Beginning Stocks: 2004/05-2008/09 Wheat Marketing Years.
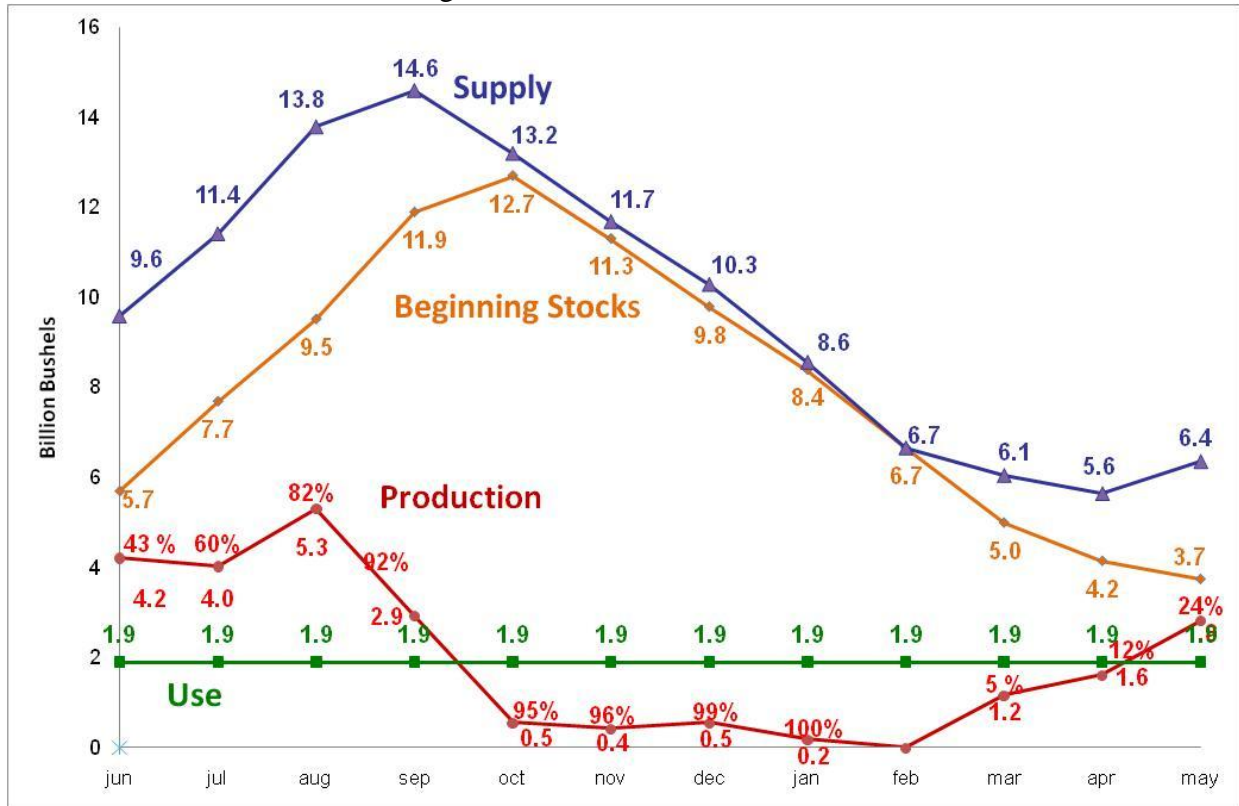
Source: USDA PS&D Data Series

Using the five-year average, wheat-beginning stock is lowest in May with 3.8 billion bushels and was the highest in October with 12.7 billion bushels. World wheat beginning stock increased from June through October, and declined from November through May.

Supply

Supply is the total amount of wheat that is available during a month. Beginning Stocks and Supply are equal on the first day of each month. The Supply shown is the beginning stocks plus all wheat that is produced during the month. If monthly production is greater than use, supply increases. If monthly production is less than monthly use, supply decreases. Supply peaks in August/September time-period and is the lowest in the March/April time-period.

Price

During the 2007/08 wheat marketing year, U.S. monthly wheat prices averaged from 25 to 121 percent higher than the 2006/07 marketing year average monthly prices. The 2006/07 marketing-year average annual price was 24 percent higher than the average of the previous four years. Prices during the 2007/08 and 2008/09 were abnormally high. Thus, the 2002/03 through

2006/07 average monthly wheat prices were used to represent the normal U.S. wheat marketing-year price trend.
When U.S. monthly wheat prices are averaged for the 20, 15, and 10 year averages ending with the 2006/07 marketing-year prices, the trend peaks in December and declines about 10 cents between December and May.

Using the 2002/03 through 2006/07 marketing-year monthly average prices, wheat prices are the lowest in June and July ($3.35 and $3.33), increase about 55 cents into November ($3.88), and remain in the $3.80 to $3.88 range through May.

World wheat supply (Figure 3) is the lowest in April and world wheat monthly beginning stocks (Figure 3 and 4) is the lowest in May. During August through September, U.S. wheat prices are increasing at the same time world wheat supply and stocks are increasing. This appears to be contrary to economic logic and theory. Economic theory suggests that prices should decline as supply increases. It might have been expected that wheat price would decline from June to October when wheat production is increasing, but wheat prices bottom out in July. One explanation that has been given is convenience yield. The convenience yield theory is that millers want to be assured of a supply of wheat for the rest of the year and so they want to lock in supplies early and therefore the market does not provide an incentive for producers to continue to store.

Figure 4. World Average Monthly Wheat Production, Beginning Stocks, Prices and Percentage of Total World Wheat Production: Production and Stocks 2004/05–2008/09; Price 2002/03–2006/07.
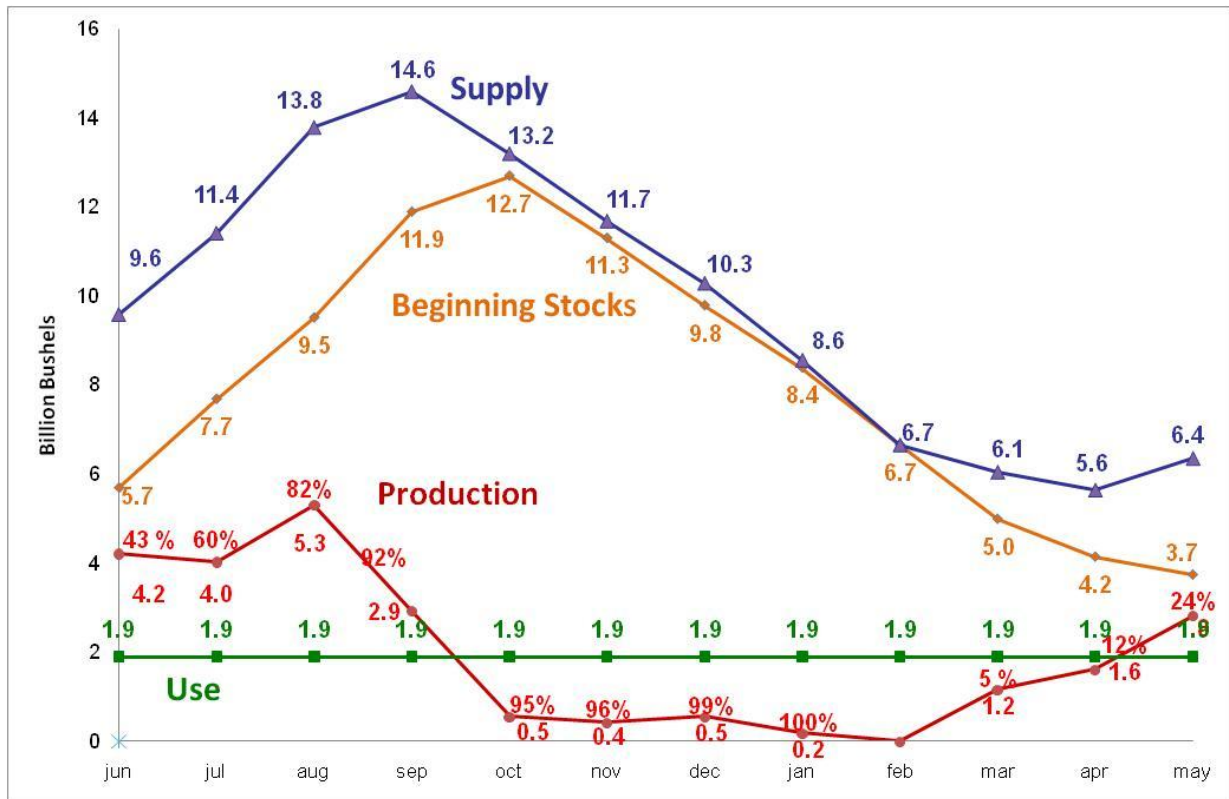
Percentages are the percentage of total marketing year production

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Note that wheat stocks peak in October; that on September 30, 92 percent of the worlds wheat has been harvested; and that prices peak in November. By November, the only wheat to be harvested is in Argentina, Australia (both Major Exporters) and a very small percentage in South Africa and South America. By November, wheat importers essentially know the exportable wheat supply. All the market has to do is allocate the wheat between November and June when the next export harvest begins.

Conclusion

Nearly 70 percent of the world's wheat is harvested during the May through August time period. Most of the remaining 30 percent is harvested in April, October, November, and December. No wheat is harvested in February, and an insignificant amount of wheat is harvested in January and March.

By the end of September, 95 percent of the world's wheat marketing-year supply is known. By the end of September, marketing-year wheat use is also mostly known. All that remains is for the market to distribute the wheat in storage during the time period October through May when the U.S. harvest begins.

The market requires that some wheat be maintained in storage and in the pipeline. Thus when stocks are relatively low, prices may react to expected production. U.S. wheat prices tend to be the lowest in June and July (harvest) and peak in October through November. Most years, the market price offers a profit for carry (storage and interest) between June and October. After October, most of the world's marketing-year wheat is in storage. Thus, the market only has to offer a price to entice owners to sell a storable commodity.

Study 2
World's Wheat Exports, Imports and Prices

Wheat is grown in nearly every country and consumed by nearly all humans. The price of wheat is partially determined by the world's supply of and demand for wheat.

Wheat classes and grades and standards are not consistent from country to country. In the United States (US), there are eight classes of wheat: hard red winter, hard red spring, soft red winter, hard white, soft white, durum, unclassed and mixed wheat (FGIS/USDA). There are additional wheat subclasses for durum and hard red spring wheat.

Hard red winter wheat makes up about 40 percent of US wheat production. Hard red spring production is about 19 percent, soft red winter wheat about 22 percent, white wheat about 12 percent and durum about 4 percent of US wheat production.

Wheat grades and standards were established and are maintained by the Animal and Plant Health Inspection Service (APHIS, USDA). The grades are USDA Grade No. 1 through 5 and sample grade. There are also special grades like infested, smutty, garlicky, etc. Dockage (matter that may be easily removed) and moisture are not grade characteristics but are included on the USDA grade form.

For the eight wheat marketing years 2000/01 through 2007/08, world wheat consumption was greater than production in seven of the eight years. Only in the 2004/05 marketing year was production greater than consumption. The result was a decline in world wheat ending stocks from 7.595 billion bushels in 2000/01 to 4.449 billion bushels in 2007/08. The world's wheat stock-to-use ratio declined from 33.4 percent, and near record high, to 19.2 percent, a record low. To ration the scarce wheat stocks, 2007/08 marketing year wheat prices increased.

World Wheat Production

The largest unit producer of wheat is the 27 countries of the European Union (EU-27) with an average of 4.89 billion bushels of wheat per year (WASDE/WAOB/USDA). China is the second largest producer and largest single country producer with a five year average of 3.82 billion bushels per year. India is the third largest producer with an average of 2.68 billion bushels per year. United States is the world's fourth largest wheat producer with an average of 2.13 billion bushels per year.

Major Exporters' Production and Exports

Major wheat exporters, as specified by the USDA, are Argentina, Australia, Canada, EU-27 and the United States (WASDE/WAOB/USDA). During the 10-year period of 2000/01 through 2009/10, total world wheat exported 4.3 billion bushels. Argentina exported 8.1 percent of the world's wheat exports. Australia exported 11.9 percent. Canada exported 14.1 percent, the EU-27 13.6 percent and the US exported 23.4 percent of the world's exported wheat. Major exporters exported about 72 percent of the world's wheat exports.

During the last few years, a second tear of exporters have emerged. These include Kazakhstan, Russia, and the Ukraine of the Former Soviet Union (FSU). During the 10-year period 2000/01 through 2009/10, Former Soviet Union countries' average percentage of world wheat exports was 18.5 percent. FSU export percentage was 26.3 percent in 2008/09 and is projected to be 28.1 percent in 2009/10.

Russian wheat exports are projected to be 14.4 percent of world exports in 2009/10 and have averaged 9.1 percent during the last 10 years. Kazakhstan averaged 4.6 percent. Ukraine's exports have averaged 4.5 percent. During the last four years, US exports as a percentage of world exports have declined from 29.4 percent to 18 percent. FSU wheat exports as a percentage of world exports have increased from 19 percent to 28.1 percent.

The major exporters plus the FSU exporting countries export about 90 percent of the world's wheat exports.

Major Wheat Importers

The major wheat importers are Brazil, China, North African countries, Pakistan, South Eastern Asia countries, and Select Middle East countries. Except from Brazil, the major importers are in the Eastern Hemisphere. This may give a transportation advantage to the major exporters in European and Former Soviet Union regions.

From 2000/01 to 2009/10, 10-year average major importers imported 1,812 million bushels. Brazil imported 241 million bushels, 13% of total major importers. China imported 58 million bushels, 3%. North Africa imported 661 million bushels, 37%. Pakistan imported 56 million bushels, 3%. Select Middle East imported 442 million bushels, 23%. Southeast Asia imported 272 million bushels, 21%.

Wheat Uses

Hard red winter wheat accounts for about 40 percent of total US wheat production and is grown primarily in the Great Plains (Texas north through Montana). Hard red winter wheat is principally used to make bread and all purpose flour. Hard red spring wheat accounts for about 19 percent of US production and is grown primarily in the Northern Plains (North Dakota, Montana, Minnesota, and South Dakota). Hard red spring wheat is valued for high protein levels,

which make it suitable for specialty breads and blending with lower protein wheat for bread flour.

Soft red winter (SRW) wheat, accounting for 15-20 percent of total production, is grown primarily in states along the Mississippi River and in the Eastern States. Flour produced from milling SRW is used in the United States for cakes, pastries, and crackers.

Soft white wheat, accounting for 10-15 percent of total production, is grown in Washington, Oregon, Idaho, Michigan, and New York, and its flour is used for crackers, pastries, quick breads, and white-crusted breads.

Hard white wheat is a relatively new wheat class in the US but, is prevalent in other countries like Australia. Hard white wheat is only grown on a few million acres in the US and is used in bread, tortillas and noodles.

Durum wheat, accounting for 3-5 percent of total production, is grown primarily in North Dakota and Montana and is used in the production of pasta flour.

Wheat Prices

Cash wheat prices were obtained for the Louisiana Gulf Port, Kansas City, Chicago, Minneapolis, and an US average price (http://www.ers.usda.gov/data/wheat/YBtable20.asp). Louisiana Gulf prices are for hard red (HRW) and soft red winter (SRW) exported wheat. Kansas City prices are for HRW wheat. Chicago prices are for SRW wheat and Minneapolis prices are for hard red spring (HRS) wheat. Price series for durum wheat and hard white wheat were not included in this study. A weighted average price series for all classes of wheat at the local elevator (farm level) was included.

World wheat price quotes include Argentina, Australia, Canada, and Rotterdam. Argentina produces both a SRW and HRW winter wheat. Australia's major wheat class is hard white wheat. Canada's major wheat class is hard spring. Rotterdam is a major export and import center for Europe.

Prices used in this report are five-year monthly averages from June 2002 through May 2007 (Figure 5). Prices for years June 2007 through May 2009 were excluded because they were judged to be abnormally high. The US monthly average wheat price went from $4.70 in May 2007 to $10.50 in March 2008, a 223 percent price increase. In some locations, cash wheat prices reached $14 for interior hard red winter wheat and $26 for spring wheat (USDA/NASS).

The US average prices are lower than the other price series because the US average price series is farm level prices compared to the other prices that are for terminal markets. The US wheat average price tends to be the lowest in July and highest in October. United States average wheat prices remain almost constant from October through May. This price series indicates that, on average, the market does not pay for storage and interest costs in the October through May time period.

As explained in the first study, "The World's Wheat Supply," prices tend to peak in October when about 95 percent of the world's marketing year wheat production has been harvested.

Louisiana Gulf soft red winter wheat has the second lowest average prices. The seasonal pattern has prices the lowest in June and the peaking in January. The difference between the monthly average October price and the average January price is only six cents ($4.16 vs. $4.22).

Hard red winter wheat prices in Kansas City and at the Louisiana Gulf have nearly the same seasonal pattern. Both peak in the October/November time period, decline into January (about 20 cents) and remain about the same until the June harvest. The Kansas City June and July average price are within one cent of each other while the Gulf average monthly price increases 13 cents between June and July. The increase may be due to the lag between harvest timing in Oklahoma and Kansas and the time it takes to deliver new-crop wheat to the gulf.

Hard red spring wheat in Minneapolis had the highest average monthly prices. This is probably due to protein (14%) and the fact that Minneapolis is a major milling and terminal point for HRS wheat.

Wheat in Louisiana Gulf Port has highest average monthly spread (68 cents) with variance of six cents. US farm level price has the lowest price spread (50 cents) and variance 5 of cents.

Figure 5.United States Farm Level and Select Location Monthly Average Wheat Prices: June 2002 through May 2007
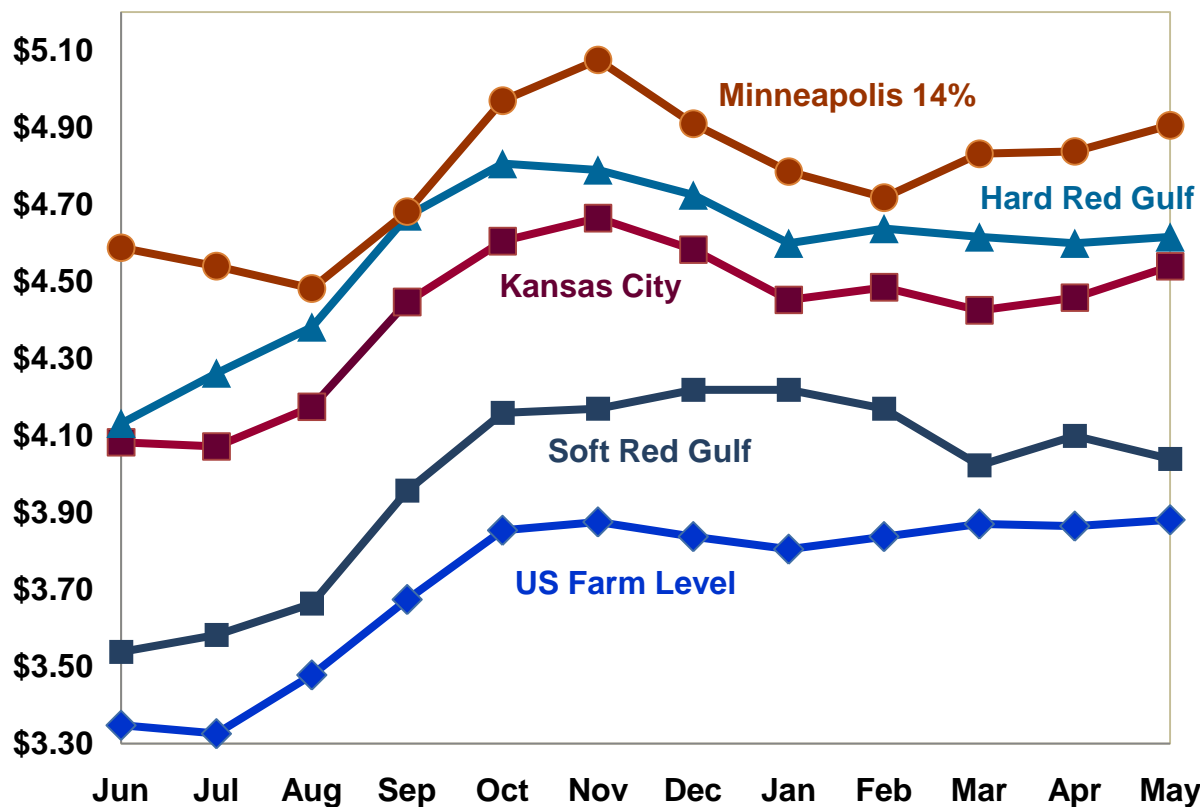
United States versus Other Major Exporters

Figure 6 shows average monthly wheat prices for the United States, Argentina, Australia, Canada and Rotterdam. The US wheat price is a weighted average of all classes of wheat at the farm level. Argentina wheat prices are a combination of HRW and SRW farm level prices. The Rotterdam market trades both winter, and spring wheat. Canada trades a majority of spring wheat. Australian wheat is mostly hard white winter wheat. Argentina trades hard and soft red winter wheat.

Figure 6. US and Select World Monthly Average Wheat Prices
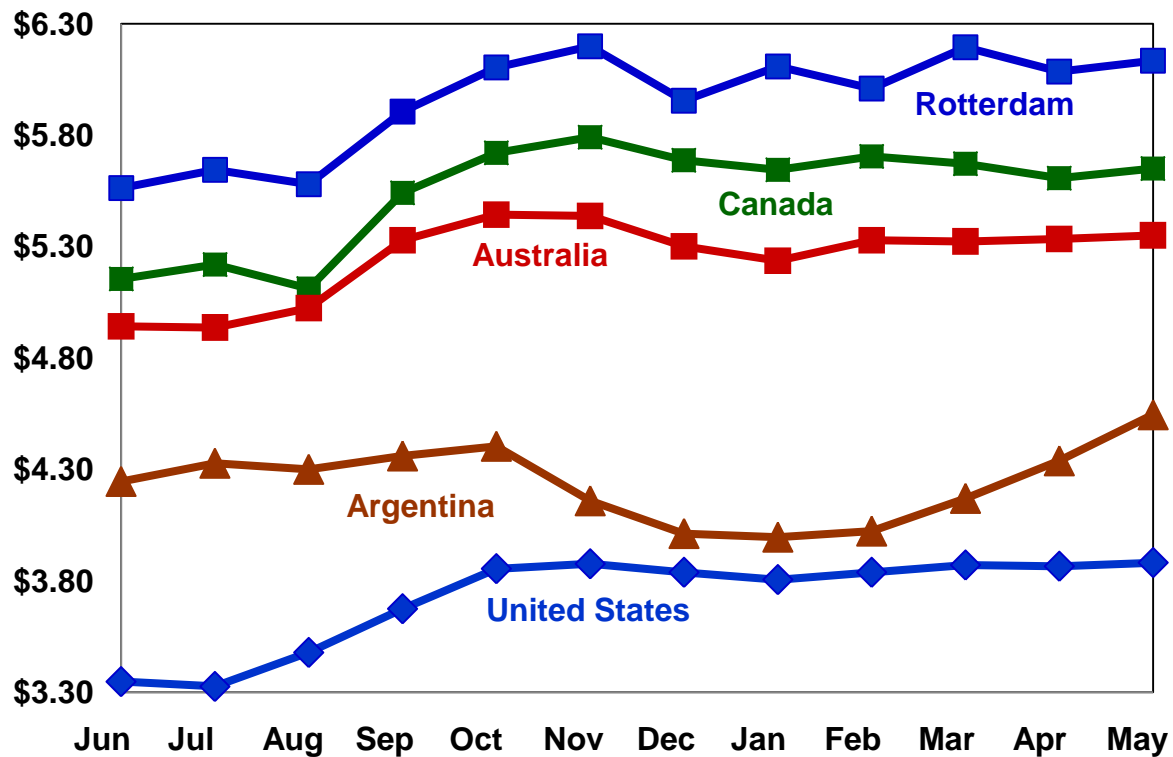
US average price is lowest because it is at farm level. Rotterdam, Canada, Australia, and Argentina prices are higher than US Average because they are at export level, which included interior transportation cost.

Rotterdam, Canada, Australia, and US prices have the same seasonal trend because they have similar harvesting calendar. Lowest price is in June, highest in November. From June to August, prices are low because most of world wheat is harvested in June-August. 82 percent of world wheat production is harvest by August. Prices are increasing from August to their peaks in November because world wheat production is decreasing during this period. By November, 96 percent of world wheat production is harvested.

Rotterdam prices are highest. This is mostly due to they have transportation advantage when export to Asia and Africa. It has highest price is in November, $6.20 per bushel, lowest price in June $5.56, variance is 6 cents. There is a price impulse up and down one month after the other

from November to May, but the changes are small, around 10 cents. This happens probably because Rotterdam is European wheat import and export center. There are lags in harvest among European countries.

Canada and Australia have nearly same seasonal pattern. Canada has higher prices than Australia. This is probably due to Canada trading spring wheat which has higher protein content than the winter wheat that Australia traded. Both countries' prices peak in November, then decline until January (about 20 cents for Australia, 15 cents for Canada). Australia has a deeper decline because it harvests wheat during October through early January. Canada's price is relatively low in August due to wheat harvesting. Canada's highest price is in November ($5.79), its lowest is in June ($5.15), while Australia's highest price is $5.44 and its lowest price is $4.49.

Right above US average seasonal price is Argentina. Argentina's price peaks in May at $4.55, stay, and remains high until October and then declines to lowest in January $4.00. Variance is 3 cents. Argentina has a different seasonal price pattern than other countries because it is South Hemisphere country with a different harvest calendar. Argentina has highest price in May, stays constant until October. After October, it declines into January and then increases to peak. Similar to other countries, Argentina's price is decreasing during harvest periods (mid November-January). When most of wheat production is harvested, price will increase to peak (January to May) and stay constant until next year's harvest. Argentina market does not pay for interest and storage cost from May to October.

Conclusion

The 10-year-average (20000/01-2000/2010) world's wheat production is 23 billion bushels. The world exported 4.3 billion bushels. Major export countries plus Former Soviet Union exported 90% of world wheat export. Major exporters are Argentina, Australia, Canada, EU-27, United States

Major importers are Brazil, China, North Africa, Pakistan, South Eastern Asia, and Middle East countries. Major importers imported 46% of the world's exports (around 1.8 billion bushels).

All wheat price series except Argentina peak in October/November. Wheat prices are lowest in June/July. Prices stay almost constant at peak from October to May. This indicates that the market does not pay for storage and interest costs.

Wheat prices tend to decline during harvest. They are increasing when wheat production is decreasing.

High-protein-content wheat like hard red spring wheat has very high prices.

Study 3
Rework of a Simplified Procedure to Predict Seasonal Average Wheat Price

This article re-estimates the model by Anderson and Tweeten (1975) in which they estimated the effect of ending stocks on wheat price. Given United States Department of Agriculture (USDA) projections of ending stocks, the regression can be used to predict wheat price. This article gives analysts a simple tool that can estimate wheat prices based on wheat supply/demand information. Anderson and Tweeten (1975) used data from 1955-1973. This article re-estimates their model using data from 1975 to 2008.

Understanding market factors that affect price is a topic that has attracted many researchers. Westcott and Huffman (1999) studied the effect of stocks-to-use ratio and government policy factors on US farm level price of corn and wheat. Goodwin, Schnepf, and Dohlman (2005) researched the influence of stocks-to-use ratios, loan deficiency payments, drought years, and loan rates on soybean price. Their results confirmed stocks-to-use ratio is an important indicator for demand/supply factors. Following their results, this research will study the effect of utilization to stocks ratios for both wheat and feed grains, and government policies on wheat prices.

Data

Wheat prices are the seasonal average prices of all wheat. The prices were obtained from the Wheat Yearbook Table 20: US and Foreign Wheat Prices of Economic Research Service (ERS) of United State Department of Agriculture (USDA) (http://www.ers.usda.gov/Data/Wheat/YBtable20.asp) for years 1975-2008. Prices used in this model are real prices. The prices were deflated by the Producer Price Index (PPI) of farm products, processed foods and feeds with base year 1982. The PPI is collected from Bureau of Labor Statistics (http://data.bls.gov/cgi-bin/dsrv?wp).

Wheat utilization, feed grain utilization, and ending stocks are from an ERS database query (http://www.ers.usda.gov/Data/FeedGrains/CustomQuery/). The wheat and feed grain utilizations are the sum of total domestic usage and exports. Wheat utilization to ending stocks ratio is calculated by dividing wheat utilization by wheat ending stocks. The same method is used to calculate feed grain utilization to ending stocks ratio. A wheat marketing year starts at June 1st and ends on May 30th. For feed grains, the marketing year starts at September 1st, and ends on August 31st.

Wheat price equation:

Wheat prices can be predicted by the ratio of wheat to ending stocks, the ratio of feed grain use to stocks, and dummy variables for government policy in two different periods 1986-1996 and 1996-2008. The equation estimating wheat prices is

$$P_t = 2.7963 + 0.36703 \frac{WUT_t}{WST_t} - 0.00713 \frac{FGUT_{(t-1)}}{FGST_{(t-1)}} - 1.39206 D_{1t} - 1.44485 D_{2t} \qquad .$$

$$\qquad\qquad\qquad (5.05) \qquad\qquad (-0.25) \qquad\qquad\qquad (-5.68) \qquad\quad (-6.58)$$

$R^2 = 0.6279$, and t-values are in parentheses. Where:

P_t = Average seasonal wheat prices in year t.

WUT_t: Wheat utilization, domestic and export in year t, measured in million bushels

WST_t: Wheat total ending stocks in year t, measured in million bushels

$FGUT_{(t-1)}$: Feed grain utilization (domestic and export) in year t-1, measured in million bushels

$FGST_{(t-1)}$: Feed grain total ending stocks in year t-1, measured in measured in million bushels

D_{1t}, D_{2t}: Dummy variables reflect the policy change in different periods 1987-1996, and 1997 to 2008. $D_1 = 1$ for period 1987-1996 otherwise $D_1 = 0$, $D_2 = 1$ for the period 1997-2008 otherwise $D_2 = 0$.

Anderson and Tweeten (1975) obtained the following result, estimated over the period 1955-1973:

$$P_t = 0.08868 + 0.344 \frac{WUT_t}{WST_t} + 0.1388 \frac{FGUT_{(t-1)}}{FGST_{(t-1)}} - 1.1138 D_{1t} \qquad .$$

$$\qquad\quad (6.69) \quad (1.90) \quad (8.02)$$

$R^2 = 0.89$

The coefficient of wheat utilization to ending stocks ratio, 0.36703, is higher for the recent period, compared to 0.344 during the 1955-1973 period. When the ratio of wheat utilization to ending stocks in the 1975-2008 period increased by one unit, wheat prices increased by 36.7 cents. In contrast, for the same one-unit increase in wheat utilization to ending stocks ratio during 1955-1973, wheat prices increased by 34.4 cents.

The coefficient of feed grain utilization to ending stocks in 1975-2008 (-0.00713) is not statistically significant in explaining wheat prices. In contrast, during 1955-1973, the same coefficient (0.1388) was significant in explaining wheat prices. As feed grain utilization to ending stocks increased by one unit, wheat prices increased by 13.88 cents. During that time period, wheat was abundant. More wheat was used as livestock feed. Now, only low-quality

wheat is fed to livestock. Therefore, feed grain stocks no longer have the same impact on wheat prices.

Anderson and Tweeten (1975) argued that the two-price system from 1963 to 1975 was associated with lowering wheat prices by $1.11 per bushel. This reworked model also examines the effect of government policy for two different periods, 1986-1996 and 1997-2008. The result found that government policy was associated with lowering wheat prices by $1.53 per bushel in 1986-1996, and $1.58 per bushel in 1997-2008, after taking out the insignificant variable, feed grain utilization to ending stocks ratio (see reduced model below).

Relationship between wheat prices and the other independent variables

Because the coefficient of feed grain utilization to ending stocks ratio is not statistically significant in estimating wheat price, the equation estimating wheat prices is reduced to

$$P_t = 2.81513 + 0.3846\frac{WUT_t}{WST_t} - 1.528226D_{1t} - 1.58012D_{2t}$$

$$(5.53) \qquad (-6.15) \qquad (-7.14)$$

$$R^2 = 0.6448$$

The results show that coefficient of the ratio of wheat utilization to ending stocks is significant in explaining wheat price. The coefficient indicates that as wheat utilization to ending stocks ratio increases by one unit, wheat prices will increase by 38.5 cents.

A joint statistical test also found the coefficients of the dummy variables significant in explaining wheat price. Government policy in 1986-1996 associated with lowering wheat prices to by $1.53 per bushel. The 1997-2008 government policy associated with lowering wheat prices by $1.58 per bushel. Setting dummy variables $D_1=D_2=0$ for estimating wheat prices in period 1975-1986; $D_1 = 1$, $D_2 = 0$ during period 1987-1996; and $D_1 = 0$, $D_2 = 1$ during 1997-2008.

Table 1. Descriptive Statistics of Variables

Variables	Mean	SD	Maximum	Minimum
Price ($/Bu)	3.07	0.69	4.78	2.06
Wheat utilization (WUT) (mil bushels)	2285	221.75	2684	1704
Wheat ending stocks (WST) (mil bushel)	853.50	409.96	1905	306
Wheat utilization-stocks ratio (WUT/WUS)	3.28	1.51	7.61	1.03
FG utilization (FGUT) (mil bushels)	9020	1422	12643	6659
FG ending stocks (FGST) (mil bushels)	2032	1147	5590	529.72
FG utilization-stocks ratio (FGUT/FGST)	5.65	2.95	16.88	1.49

Table 1 provides descriptive statistics of all variables. The average wheat price of the studied period was $3.07 per bushel. The highest wheat price was $4.78 per bushel in 1975; the lowest wheat price was $2.06 per bushel in 1999.

Wheat utilization has a mean of 2,285 million bushels. In 1987, wheat utilization was highest, 2,684 million bushels. Year 1976 was the year wheat was used the least, 1,704 million bushels. Wheat ending stocks have averaged 854 million bushels. In 1985, wheat ending stocks were at their highest level at 1,905 million bushels. Year 2007 had the lowest wheat ending stocks, 306 million bushels. The average ratio of wheat utilization to ending stocks is 3.29. The highest ratio was 7.61 in 2007. Highest wheat utilization to ending stocks ratio was in the same year, with the lowest wheat ending stocks. The lowest ratio was 1.03 in 1985, when wheat ending stocks were highest.

Feed grain utilization averaged 9,020 million bushels. Highest feed grain utilization was 12,643 million bushels in 2007. Lowest feed grain utilization was 6,659 million bushels in 1976. The feed grain ending stocks' average is 2,032 million bushels. Highest feed grain ending stocks was 5,590 million bushels in 1986. Lowest feed grain ending stocks was 530 million bushels in 1995. The average of ratio of feed grain utilization to ending stocks is 5.65. The highest ratio is 16.88 in 1995. Like wheat, the ratio of feed grain utilization to ending stocks was highest when feed grain ending stocks was lowest, in 1995. The lowest feed grain utilization to ending stocks ratio was 1.49 in 1986. Again, feed grain utilization to ending stocks ratio was lowest in the highest ending stocks year, 1986.

Figure 7. Wheat Prices vs. Predicted Wheat Price

Price

4.5

4

3.5

3

2.5

2

75

79   07
80
08
95
76
82   83   78 81
88   89   96   77   83   85
06   94
02   93   92   91
97   03
87   05   04   86
98 01 90
99 00

2   2.5   3   3.5   4
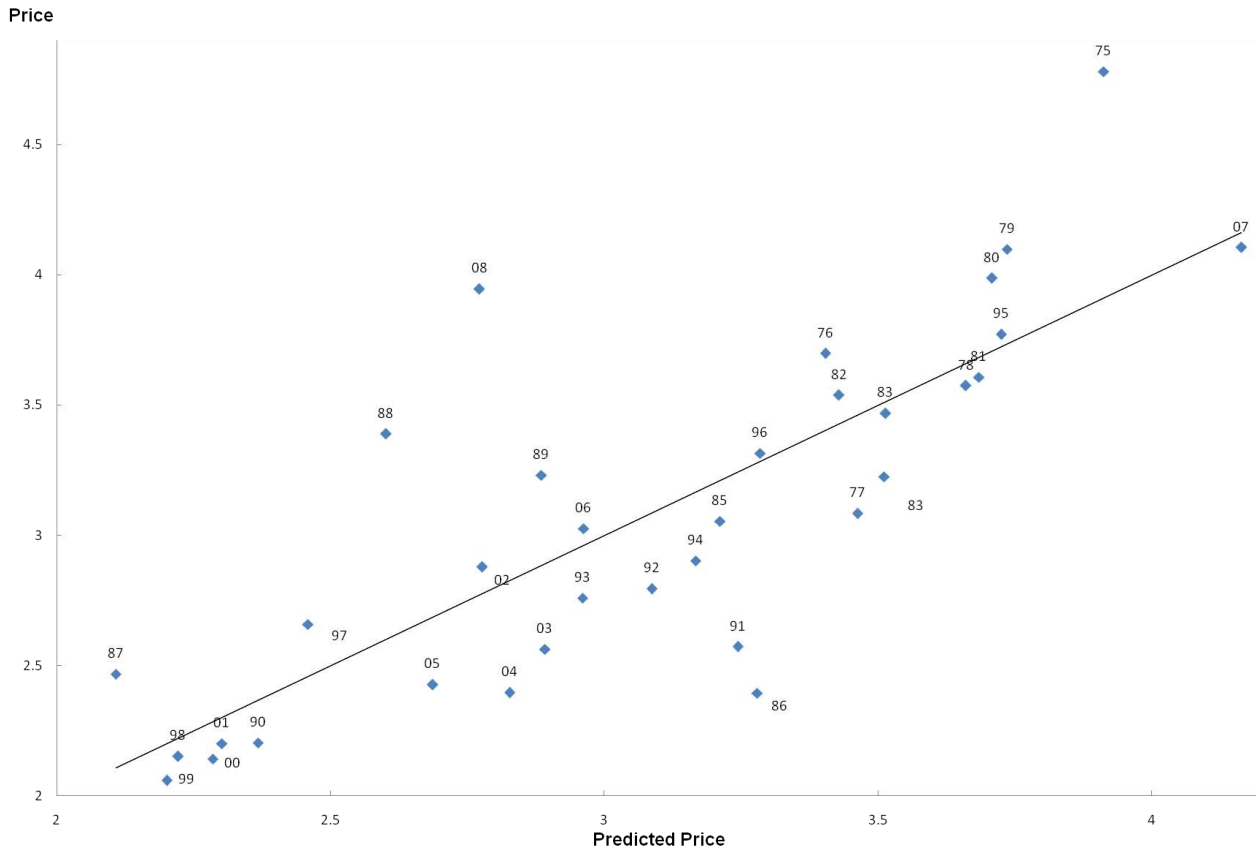
Predicted Price

Figure 7 plots the relationship between real wheat prices and predicted wheat prices during the 1975-2008. Real wheat prices are on the vertical axis, and predicted wheat prices are on the horizontal axis. All data points are labeled by years. The purpose of this graph is to show how well the data fit the model. Most data points are very close to the line. Correlation between price and predicted price is 0.8. Both statistical and graphical evidences indicate that the model fits the data very well.

However, there are some outliers in years 1975, 1986, 1988, 1991, and 2008. Wheat prices in 1986 were relatively low. There was abundance of wheat supply in 1986 because the Farm Bill (PIK&Roll) sold a lot of government-owned stocks to the market in plus 1986 production. High wheat supply depressed wheat price in 1986. In contrast, low ending stocks caused high 1986 predicted price. The same situation repeated in 1991.

In 1988, there were low beginning stocks. It caused high average monthly prices for first half of the year. It caused high annual average wheat prices in 1988. However, high 1988 ending stocks caused low 1988 predicted wheat price. The same situation as 1988 happened in 1975 and 2008.

Wheat price estimation

Figure 2 plots all data points from 1975 – 2008 with wheat prices on the vertical axis, and the ratio of wheat utilization to ending stocks on the horizontal axis. Wheat prices equation with the dummy variables $D_1 = 1$ and $D_2 = 0$ to estimate wheat prices in 1987-1996 is also plotted in Figure 2.

Figure 8. Wheat Prices vs. Wheat Utilization To Stocks Ratio
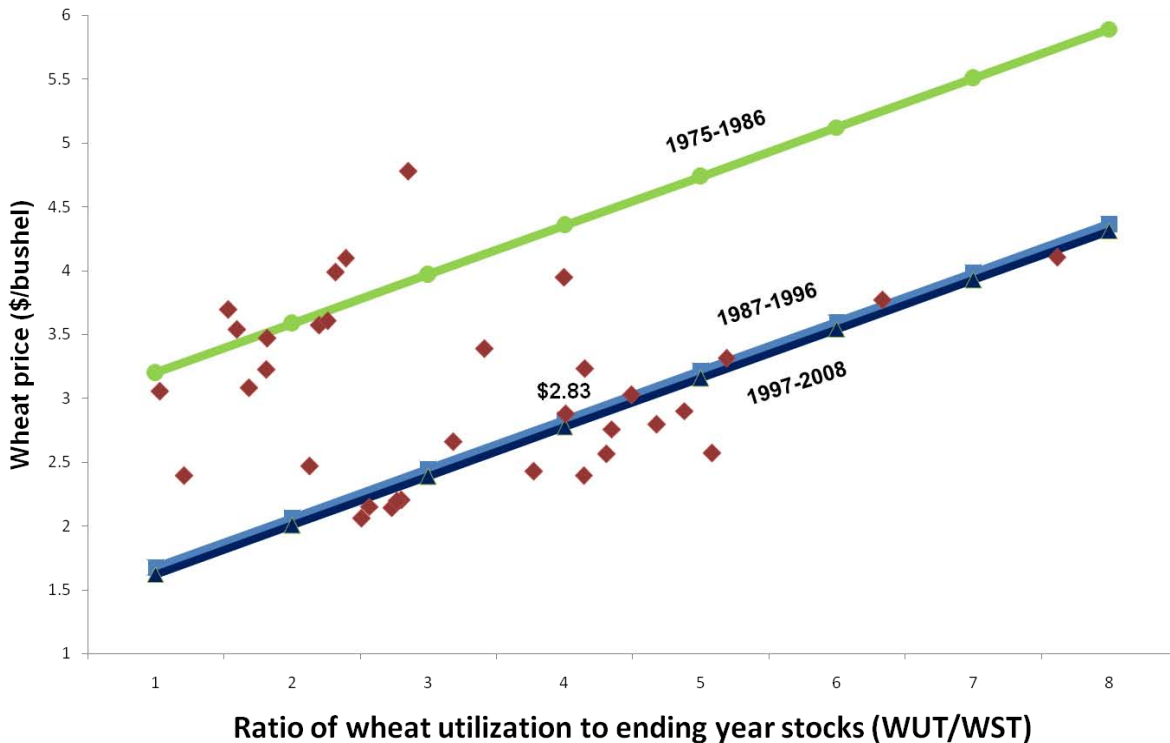
In addition, Figure 8 visualizes the relationship between wheat prices and wheat utilization to ending stocks ratio. As shown, wheat prices are increasing when wheat utilization to ending stocks ratio is increasing.

This figure can be used as a guideline to estimate wheat price, using the World Agriculture Supply and Demand Estimate (WASDE) report. First, one needs to find the ratio of wheat utilization to ending stocks for year t by dividing wheat utilization in year t by wheat ending stocks in year t. Finally, he/she plugs those numbers into the above equation, and set $D_1 = D_2 = 0$ for estimating wheat prices in 1975-1986, $D_1 = 1$, $D_2 = 0$ for estimating wheat prices in 1987-1996, $D_1 = 0$, $D_2 = 1$ for estimating wheat prices in 1997-2008.

For example, if wheat utilization to ending stocks ratio is 4, the predicted wheat prices will be $2.83 for period 1987-1996. The price estimated is real price. It can be inflated to current dollar price by multiplying the real price by the current year Producer Price Index and dividing by 100.

Conclusion

The purpose of this study is to give analysts a tool to estimate wheat prices based on wheat supply/demand information. By understanding the relationship between wheat price and wheat utilization to ending stocks ratio, analysts can better anticipate shift in wheat prices when due to changes in market conditions such as favorable weather, low exports, low wheat consumption, etc.

This model has some limitations in predicting wheat price. Error will arise when wheat supply and demand information such as wheat production, carryout, and usage are incorrectly anticipated. However, an advantage of this model is it is simple to use. It combines supply and demand into a reduced form that is easily adapted by decision makers.

The re-estimated model with data ranging from 1975 – 2008 is slightly different from the model used data from 1955 – 1973 (Anderson and Tweeten, 1975). During 1975 – 2008, the ratio of feed grain utilization to ending stocks is not significant in explaining wheat price. In contrast, in 1955 – 1973, the same ratio has a positive relationship with wheat price.

Moreover, this article found that government policies were associated with lowering wheat prices by approximately $1.53 per bushel during 1987 – 1996, and by $1.58 during 1997-2009. Meanwhile, Anderson and Tweeten (1975) found that government policy in 1955 – 1973 lowered wheat prices by $1.11

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Scope and Method of Study: this thesis is composed of three studies. They will provide farmers,
    decision makers, and analysts information about wheat supply, demand, and prices. The
    first study, World's Wheat Supply, provides an overview about world's wheat
    production, stocks, consumption, harvest calendar, and 10-year average monthly price
    trend of major wheat producing countries. The second study, World's Wheat Exports,
    Imports, and Prices, provides information about world's wheat exports, imports of major
    exporters, importers. In addition, it compares monthly price trends among classes of
    wheat, and major exporters. The data are from Economic Research Service of United
    States Department of Agriculture (USDA). The third study, Rework of a Simplified
    Procedure to Predict Seasonal Average Wheat Price, provides an explanatory model of
    wheat price. It provides analysts, decision makers with a simple model to estimate wheat
    price based on supply/demand information from the World Agriculture Supply and
    Demand Estimate (WASDE) report of USDA.

        Advisor's Approval: __Dr. Kim Anderson__