NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

The Competitive Position of the Black Sea Region in World Wheat Export Markets

by

Daniel M. O'Brien and Frayne Olson

Suggested citation format:

O'Brien, D. M. and F. Olson 2014. "The Competitive Position of the Black Sea Region in World Wheat Export Markets." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

The Competitive Position of the Black Sea Region in World Wheat Export Markets

Daniel M. O'Brien

and

*Frayne Olson**

Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management
St. Louis, Missouri, April 21-22, 2014

* Daniel M. O'Brien is an Associate Professor and Extension Agricultural Economist in the Department of Agricultural Economics at Kansas State University. Frayne Olson is an Assistant Professor and Crop Economist in the Department of Agribusiness and Applied Economics at North Dakota State University.

The Competitive Position of the Black Sea Region in World Wheat Export Markets

Differences in physical quality characteristics among classes or types of wheat are often reflected in global cash wheat prices in general, and in wheat prices and sales involving major Black Sea Region exporters Russia, Ukraine and Kazakhstan in particular. Black Sea Region wheat export markets appear to be somewhat associated with each in other in terms of price dynamics, while still exhibiting important differences. Differences in wheat class quality characteristics and logistical-transportation factors play an important role in determining the competitive, cointegrated nature of world and Black Sea Region wheat market price relationships, along with the dynamics of changing wheat supply-demand balances. Black Sea Region wheat prices display some degree of price interrelatedness for milling quality wheat, but not complete uniformity. Ukraine milling wheat export prices show evidence of being cointegrated with German milling wheat export prices, but less so with with those of Russia. Russian milling wheat export prices appear to be cointegrated with both U.S. hard red winter and soft red winter wheat export prices, but less so with those of the Ukraine. Kazakhstan milling wheat export prices show evidence of being somewhat associated with Russian milling wheat export prices, but not so with those in Ukraine.

Key Words: wheat, export trade, quality differentials, trade logistics, Black Sea Region

Introduction

Since the middle 1990s the volume of wheat export trade of Black Sea Region countries has grown substantially. Wheat exports from the Black Sea Region countries of Russia, Kazakhstan, and Ukraine have become an increasingly important factor in world wheat export markets. During the 2011/12 through 2013/14 marketing years combined wheat exports from these three countries accounted for an estimated 25, 18, and 22 percent of global wheat exports, respectively, and are projected to make up 23 percent of the world total in the 2014/15 marketing year (June 1, 2014 through May 31, 2015) (source: USDA PSD Online, May 29, 2014). Black Sea Region wheat exporters have benefited from their comparative shipping cost advantages to key North African and Middle Eastern wheat importing countries in comparison to global wheat export competitors. Key North African and Middle Eastern wheat importing countries include Egypt, Turkey, Iran, Yemen, Morocco, Iraq, and Israel.

Wheat production from these same three major Black Sea Region countries made up a larger proportion of global production in recent years – indicative of the focus that these three key wheat exporting countries now have on growing export business as well as their increasing relative importance in maintaining adequate world wheat supply stocks. Wheat production from Russia, Ukraine and Kazakhstan accounted for an estimated 15, 10, and 12 percent of global wheat production over the 2011/12 through 2013/14 period of marketing years, respectively, according to USDA, and is projected to make up 12 percent of the world wheat production total in the 2014/15 marketing year (source: USDA PSD Online, 5/29/2014).

From a longer term historic perspective, combined wheat exports from Russia, Ukraine and Kazakhstan have grown faster than world wheat exports overall, and subsequently have constituted a larger portion of total global wheat exports since the early 1990s. Combined wheat exports from these three countries have grown from a seven year average of 6.384 million metric tons per marketing year (mmt/yr) during the 1993/1994 through 1999/2000 marketing years, up to 16.437 mmt/yr during

2000/2001 – 2007/2008, and again up to 31.536 mmt/yr during 2008/2009 – 2014/2015. This amounts to an increase of 25.152 mmt or 394 percent from the earlier to the later seven year period, or an average increase of 1.20 mmt or 18.8 percent per marketing year.

In comparison, global wheat exports have grown from a seven year average of 103.874 mmt/yr during the 1993/1994 - 1999/2000 marketing years, to 109.800 mmt/yr during 2000/2001 – 2007/2008, and up to 146.183 mmt/yr during 2008/2009 – 2014/2015 (Figure 1). This amounts to an increase of 42.309 mmt or 40.7 percent from the early to the later period, for or an average increase of 2.01 mmt/yr or 1.9 percent per year. Due to its increasing role in global wheat exports, variability in Black Sea Region wheat production and exports has had a marked impact on total world wheat export quantities and prices since the 2007-2008 market year. Variation in the availability of global corn supplies over this same time period has also affected global wheat exports as in many cases livestock producers found it necessary to substitute wheat in feed rations for coarse grains that were in short supply in recent years.

Both higher quality "milling" wheat for food consumption and lower quality "feed" grade wheat are commonly available for export from Black Sea Region exporters, with feed quality wheat typically making up a larger proportion of export sales. Prices for wheat in global markets have a tendency to move somewhat together, but still seem to exhibit differential variability and levels by class type and location as shown in Figure 2. In a broad sense the economic principle of the "law of one price" is still held to be true in economists and other market analysts. That said, economically important distinctions exist among alternative wheat export price series due to a combination of a) the dynamics of country and region-level wheat supply-demand factors over time, b) quality characteristic differentials by wheat class, c) transportation and other logistical realities, and d) other factors that may influence wheat market prices such as public policy and inter-country macroeconomic conditions.

The objectives of this research are two-fold. The first objective is to describe existing wheat class quality characteristics across major exporting countries, and how these differences in quality characteristics are used to produce different flour-based products. Specific descriptions will be provided across the types of wheat or wheat classes available from major wheat World wheat exporter along with estimates of the proportion of particular types of wheat sold for export from each country. Short descriptions will also be given of the primary end use of each at least quasi-distinctive wheat class.

A second objective is to examine the strength of market inter-relationships or degree of cointegration of competitive Black Sea Region Country wheat export prices – both among key price series for the major wheat exporting countries in the Black Sea Region (i.e., Russia, Ukraine, and Kazakhstan), and with other major world wheat export competitors. Milling quality wheat prices will be used within the second objective.

The Unique Characteristics and Limited Substitution Among Wheat Classes in World Markets

World and United States' wheat markets may be viewed by some analysts as similar to corn and soybeans, being fairly homogenous in terms of grain quality. With this homogeneity would come a high degree of substitutability across time and world wheat production regions. However, in the United States alone there are six different wheat classes, each having distinct production, quality and end use characteristics (Table 1). There are also three separate U.S. futures markets trading Hard Red Winter (HRW), Soft Red Winter (SRW), and Hard Red Spring (HRS) wheat classes. Further, the U.S.

wheat grading system imposes price discounts or financial penalties when these distinct classes are mixed together to form "contrasting classes". For examples, substantial market price discounts will occur in the U.S. when HRW wheat and HRS wheat are accidentally mixed together.

Wheat WITHIN a specific wheat class is often blended at the local, regional or export elevator level to improve consistency and attain specific contracted quality standards for the whole grain. Types of wheat ACROSS differing classes are also often blended by flour mills prior to milling to attain specific flour quality standards. Wheat flour – produced from different wheat classes – can also be blended to improve consistency and attain specific contracted flour quality standards. Maintaining distinct class and quality standards for the whole grain wheat allows the buyer to price and purchase the set of characteristics that are desired.

However, because of the wide range of end uses for wheat and flour products, there is limited substitution BETWEEN wheat classes. For example, pizza dough made from SRW wheat instead of HRS wheat will not rise well and will easily break apart after baking – spilling all the pizza toppings. Pasta made from HRW wheat rather than durum wheat will easily break in the package and will make "pasty" noodles when cooked. Pan bread made from a blend of HRW and HRS wheat will have higher loaf volume and better water absorption rates than bread made HRW wheat only.

Although in the United States wheat prices ARE differentiated by class, they still do tend to generally move together over time due to substitution across classes for some uses. For example, the milling and baking characteristics of high protein HRW wheat are similar to the milling and baking characteristics of low protein HRS wheat.

Differing Classes in World Wheat Markets

World wheat markets are relatively liquid – trading both milling quality and feed wheat types. Milling wheat classifications vary considerably across countries. Both whole grain & flour characteristics are used to classify wheat in the World market (Table 2). Therefore, comparing wheat prices across countries ans classes is very "problematic". A wheat price quote from "Country A" may represent a different class & end use, than the wheat quote from "Country B".

Wheat classifications in the United States are compared with major exporters in the Black Sea Region, i.e., Kazakhstan, Russia, and Ukraine (Table 3), with those in Australia, France and Canada (Table 4), and with those in Argentina and Germany (Table 5). The authors are still taking comments on these classifications. Therefore these classifications should be viewed as preliminary in nature.

United States' World Wheat Export Buyers by Class

Figures 3 - 7 list the top six export buyers of U.S. wheat by major wheat class for the 2001/02 through 2013/14 marketing years. These figures show the variability in sales volumes across time and the diversity of countries, and regions of the world, that purchase alternative U.S. wheat classes. For example, Figure 3 lists the top six export buyers for hard red winter (HRW) wheat. Nigeria, Mexico and Japan are typically the top three buyers of HRW wheat with the sales volumes remain relatively stable across time. In contrast, sales volumes to Egypt and Brazil are quit variable, with minor sales

being reported in most years but large sales occurring periodically on other years. The HRW wheat sold to these countries is often used as the base wheat for their bread flours.

Figure 4 lists the top six export buyers for hard red spring (HRS) wheat. The Southeast Asian countries of Japan, Philippines, Taiwan and Korea are key markets for U.S. HRS wheat. United States export sales to these countries have been relatively consistent over time. However, HRS wheat export sales to China and the European Union have been variable over time, and are often influenced by the quality of the base wheat produced in each particular country/region. Hard red spring wheat is often a "blend" wheat used to enhance the baking characteristics of flours used for loaf bread and specialty bread products.

Mexico and Nigeria are consistent export markets for U.S. soft red winter (SRW) wheat (Figure 5). Conversely, Egypt and China have been very erratic buyers of U.S. SRW wheat, with large purchases being made periodically during years when domestic production is very low or world wheat supplies are limited. Flour made from SRW wheat is most often used for making cookies, pastries and flat breads.

Japan, Korea, Philippines, Yemen and Indonesia are the primary buyers for U.S. white wheat classes. Egypt has also purchased significant quantities of U.S. white wheat, but these sales volumes have been more variable over time. The white wheat classes are most often used for Asian style noodles and flat breads, and typically compete directly with the Australian white wheat classes in the Southeast Asian markets.

United States' durum wheat exports tend to be small, relative to the other U.S. wheat classes. Algeria, Venezuela, Nigeria and Tunisia typically purchase middle-quality durum wheat to make couscous and Mediterranean style breads. In contrast, Italy typically purchases high quality durum wheat to make pasta products. Export sales to all of these countries vary across time due to the quality and quantity of durum wheat produced within their own countries.

Collectively, Figures 3 – 7 suggest that there are regions of the world and specific countries that have preferences for certain wheat classes and quality characteristics. This diversity in preferences is primarily driven by the end use for the wheat flour and the availability of domestic wheat classes and qualities. In addition, some of the specific countries are very quality-sensitive wheat buyers, like Japan and Italy, while others are more price-sensitive wheat buyers, like Egypt and China. The combination of the diversity in desired quality characteristics and the differences in the willingness to pay makes studying the dynamics of the world wheat markets very challenging.

Wheat Price Relationships for Black Sea Region and Major Export Competitors

The second objective of this study is to examine the inter-relationships or degree of cointegration of competitive wheat export prices of price series from the major wheat exporting countries in the Black Sea Region (i.e., Russia, Ukraine, and Kazakhstan) and from other major world wheat export competitors.

Data and empirical procedures

Reliable weekly and daily cash grain price data with exchange rate adjustments are available since 2007 for several key Black Sea Region locations, including cash wheat prices at Black Sea region FOB origination locations such as Novorossiysk, Russia, and Ukraine ports (both 11.5% protein). These prices will be compared to those of other major global wheat exporters. Examination of correlations over time and of unit-root tests for stationarity and cointegration are used to determine grain price interrelationships.

The properties of selected exchange rate adjusted wheat prices are provided for major world wheat exporters on a per bushel basis in Tables 6 and 7. For each price series, information is presented which a) identifies the country and physical market location or region within that country, b) the type of wheat – either milling or feed, c) protein content – for milling quality wheat only, d) daily or weekly price series, e) number of price observations during the sample period, f) average price, g) standard deviation, and h) skewness. The time period examined for these price series is January 4, 2008 through April 4, 2014 with the exception of Canada. Canadian wheat price series were available starting in early-to-mid 2008, with one Canadian series beginning later in the middle of 2009. The price series data was obtained from Bloomberg via online terminal subscription access at both Kansas State University and North Dakota State University.

In Table 6 information on milling and feed quality prices are presented for the Black Sea Region countries of Russia, Ukraine, Kazakhstan, and Australia, while information on milling quality wheat is presented for Germany. The varying numbers of price observations indicate the frequencies and data skips of these daily and weekly price series. For the Black Sea Region milling wheat prices, the three most consistently available price series are 1) Kazakhstan 11.5 percent protein, 2) Novorossiysk, Russia 11.5 percent, and 3) Ukraine 11.5%, with the daily Azov Sea Ports, Russia series providing markedly fewer observations over the January 4, 2008 through April 4, 2014 timer period. In the cointegration analysis that follows, weekly average price data for these three price series was used to reduce the amount of substitute values that would have to be generated. Also, with some of these price series only one weekly price observation is provided.

Black Sea Region feed wheat prices are generally plagued by missing data. Only one weekly price series for lower quality wheat, i.e., Ukraine FOB, has a nearly complete set of 293 observations. Inconsistent availability of daily or weekly data for feed wheat – other than the Ukraine FOB "lower quality" wheat price limits the possibility of price cointegration analysis for this class of wheat.

Wheat price series for German markets were generally reported on a consistent basis over the time period of this study, both on a daily and weekly basis (Table 6). For the cointegration analysis that follows, weekly Rostock "higher quality", 10 percent protein prices will be used.

A number of alternative price series exist for Australian wheat, with the "Albany Western" milling and feed wheat price series selected for representation in this analysis (Table 6). As with German markets, wheat price series from Australia were generally reported on a consistent basis, but for a shorter time period (i.e., since 8/18/2009) than for other price series from other countries used in this analysis. Weekly Albany Western Hard Wheat, 13 percent protein, track price will be used in the cointegration analysis that follows.

In Table 7 information on United States' FOB Hard Red Winter (HRW), Hard Red Spring (HRS), and Soft Red Winter (SRW) wheat prices are presented. The U.S. daily and weekly price series generally have a smaller number of missing prices – especially the generally reported FOB prices for these major wheat classes. Compared to the overall U.S. Hard Red Winter FOB prices, weekly prices for U.S. Gulf Hard Red Winter Wheat at 11.5% protein were infrequently available compared to other price series, even in comparison to U.S. Gulf Soft Red Winter wheat prices. Some classes of U.S. wheat may be used at times as livestock feed when feedgrain supply-demand and market price conditions warrant, particularly typically lower quality Soft Red Winter wheat. But in this analysis each of the U.S. wheat price series will be considered to represent "milling quality" wheat.

For the U.S. milling wheat prices, the three weekly price series that will be used in the cointegration analysis that follows are 1) U.S. Hard Red Spring wheat - FOB, 2) U.S. Hard Red Winter wheat - FOB, and 3) U.S. Soft Red Winter wheat – FOB, based on observations over the January 4, 2008 through April 4, 2014 time period.

Wheat price series for Canadian markets represent Hard Red Spring, Hard Red Winter, Soft Red Winter, and Soft White wheat classes at varying locations, both on a daily and weekly basis (Table 7). Canadian wheat price series were generally consistent and lacking in missing data observations, but they were not as consistent as either U.S. or German wheat price series. Canadian price series were nearly identically correlated with U.S. price series for HRS, HRW, and SRW varieties. Therefore, in the market price cointegration analysis that follows Canadian price series were not directly included, but instead assumed to be represented by the weekly U.S. wheat price series for various classes.

A number of alternative price series are available Argentina wheat, with "Parana" milling and feed wheat price series selected for representation in Table 7. Argentina wheat prices have a very low correlation with other major wheat exporter prices in this data set. This low correlation is likely do to the growth in influence of the Argentina government trade and other policies upon grain exports. In recent years it appears that Argentina's governmental policies related to direct taxation of agricultural exports combined with farmer's responses to inflationary pressures within their economy (i.e., by holding grains and other agricultural commodities in storage as an inflation hedge) have impacted in the manner in which Argentina's farmers to manage their grain marketings. These factors seem to have motivated their farmers to treat wheat and other grains as value bearing financial commodities, using their retained grain storage stocks to protect their financial well-being rather than to respond in a manner typically consistent with world grain market signals. As a result, Argentina wheat prices with their low correlation to world wheat market signals will be left out of the analysis of world wheat market price cointegration that follows.

Results

Weekly price series were used in this analysis, with common methods used to fill in missing data where needed. In the case of Kazakhstan weekly prices with fewer viable observations, a reduced data set of consistently reported prices for the Novorossiysk, Russia and Ukraine milling wheat markets were used for the unit root and cointegration analysis. And due to data limitations for Kazakhstan, no cointegration tests could be ran comparing its price series against non-Black Sea Region countries.

As a preliminary step before performing the unit root and cointegration tests on these selected price series, the correlation of daily (Table 8) and weekly (Table 9) wheat prices for the selected series in

this analysis. Only marginal differences existed between the results for daily and weekly prices, so discussion here will focus on the weekly prices in Table 9. These basic symmetric correlation findings indicate that there is at least a 90% correlation between:

a) Novorossiyk, Russia 11.5 percent and Ukraine 11.5 percent prices,
b) Novorossiyk, Russia 11.5 percent and Australia Hard Wheat 13.0 percent prices,
c) Novorossiyk, Russia 11.5 percent and U.S. SRW FOB prices,
d) Ukraine 11.5 percent and U.S. SRW FOB prices,
e) Australia Hard 13.0 percent and Germany High Quality prices,
f) U.S. HRW FOB and U.S. HRS FOB prices,
g) U.S. HRW FOB and U.S. SRW FOB prices, and
h) U.S. HRW FOB and Germany High Quality prices.

Several other price series have positive correlations of 85 to 89 percent. As indicated earlier, the correlations of U.S. wheat price classes match nearly identically with those in Canada (which are not presented in this table). Also, Argentina prices display a markedly lower degree of cross price series correlation that what is reported in Tables 8 and 9.

A battery of unit root tests for price stationarity and statistical tests for cointegration were formed on a pairwise basis for the selected wheat export price series in this analysis. The unit root tests indicated that the selected price series were uniformly nonstationary. Therefore, the pairwise cointegration tests were performed on contemporaneous price series differences. Price cointegration significance test results for selected milling wheat markets are presented in Table 10. These results are presented here in outline, bullet form.

A. Wheat Prices for Russia$^{Nrvsk11.5\%}$

- Cointegrated prices: US-HRW^{FOB}, US-SRW^{FOB}
- Mixed results: Ukraine$^{11.5\%}$, Kazakhstan$^{11.5\%}$, Australia$^{13\%}$, US-HRS^{FOB}, Germany^{HighQ}
- Prices NOT conintegrated: Argentina^{Wht}

B. Wheat Prices for Ukraine$^{11.5\%}$

- Cointegrated prices: Germany^{HighQ}
- Mixed results: Russia$^{Nrvsk11.5\%}$, US-HRW^{FOB}
- Prices NOT cointegrated: Kazakhstan$^{11.5\%}$, Argentina^{Wht}, Australia$^{13\%}$, US-HRS^{FOB}, US-SRW^{FOB},

C. Wheat Prices for Kazakhstan$^{11.5\%}$

- Cointegrated prices: None
- Mixed results: Russia$^{Nrvsk11.5\%}$
- Prices NOT conintegrated: Ukraine$^{11.5\%}$

D. Wheat Prices for Australia$^{13.0\%}$

- Cointegrated prices: US-SRW^{FOB}
- Mixed results: Russia$^{Nrvsk11.5\%}$, US-HRW^{FOB}, US-HRS^{FOB}, Germany^{HighQ}

- Prices NOT conintegrated: Argentina^{Wht}, Ukraine$^{11.5\%}$

E. Wheat Prices for Germany$^{Rostock\ High\ Quality}$

- Cointegrated prices: Ukraine$^{11.5\%}$
- Mixed results: Russia$^{Nrvsk11.5\%}$, Australia$^{13\%}$, US-HRW^{FOB}
- Prices NOT conintegrated: Argentina^{Wht}, US-HRS^{FOB}, US-SRW^{FOB}

F. Prices U.S. Hard Red Winter Wheat^{FOB}

- Cointegrated prices: Russia$^{Nrvsk11.5\%}$
- Mixed results: Ukraine$^{11.5\%}$, Australia$^{13\%}$, US-SRW^{FOB}, Germany^{HighQ}, US-HRS^{FOB}
- Prices NOT cointegrated: Argentina^{Wht}

G. Prices for U.S. Hard Red Spring Wheat^{FOB} ⇨ Canada^{HRS}

- Cointegrated prices: None
- Mixed results: Russia$^{Nrvsk11.5\%}$, Australia$^{13\%}$,
- Prices NOT conintegrated: Argentina^{Wht}, Ukraine$^{11.5\%}$, US-HRW^{FOB}, US-SRW^{FOB}, Germany^{HighQ}

H. Prices for U.S. Soft Red Winter Wheat^{FOB}

- Cointegrated prices: Russia$^{Nrvsk11.5\%}$, Australia$^{13\%}$
- Mixed results: US-HRW^{FOB}
- Prices NOT cointegrated: Ukraine$^{11.5\%}$, Germany^{HighQ}, US-HRS^{FOB}, Argentina^{Wht}

As indicated earlier, prices for Canadian HRS, HRW and SRW wheat closely mirror the behavior and reactiveness of their U.S. wheat class counter parts. Among the Black Sea Region, the lack of evidence for strong cointegration between Ukraine and Russia was an unexpected result, as test results were mixed. Therefore, Ukraine prices seem to be cointegrated with German wheat – but less so with Russian prices. Russian prices seem to be cointegrated with U.S. HRW & U.S. SRW wheat export prices – but less so with Ukraine prices. Kazakhstan prices may be somewhat associated with Russian wheat prices, but not with Ukraine prices.

Summary and Conclusions

Physical differences in wheat-by-class are often reflected in U.S. & World cash wheat prices. "Heterogeneity" by wheat class in quality characteristics may be a factor in analysis & determination of the competitive – cointegrated nature of U.S. & World wheat market price relationships.

Logistical factors associated with wheat location, storage & transportation also should be considered. Quality and logistical factors operate within the context of a) dynamic supply-demand balances for transportation resources among competing world wheat exporters, and b) potential cross-market effects from coarse grains, which are heightened when there are tight coarse grain supplies leading to stronger demand for using wheat as a substitute feedstuff in livestock feed rations.

Black Sea Region wheat export markets appear to be somewhat "differentially associated" among themselves & other Non-BSR export competitors – being driven by differing quality characteristics and logistical factors. Ukraine prices seem to be cointegrated with those for German wheat – but less so with Russian prices. Russian wheat prices seem to be cointegrated with U.S. HRW and U.S. SRW wheat export prices – but less so with Ukraine prices. Kazakhstan wheat prices may be somewhat associated with Russian wheat prices, but not with Ukraine prices.

Missing price data "gaps" are a serious problem with Black Sea Region price analysis – more so for daily, but also for weekly prices. Grain quality, price and other data are "sketchy" and sometimes incomplete and gap-ridden as Black Sea Region countries are either still developing complete market reporting abilities, or their wheat market prices are not continuously bid or reported by market monitoring authorities. Current geopolitical events and governmental policies with their potential market price implications add an element of crucial relevance of this analysis.

Future work in this area may involve extension and further refinement of the current analysis, with the possible application of other econometric analysis tools to this project. These tools may include complementary Johansen Tests for cointegration on the one hand, and the use of vector autoregressions (VARs) with error correction models (ECMs) to address the price inter-ralationships and cross price dynamics of multiple time series as used in this application. Also, a supportive hedonic analysis of the market value of wheat quality factors could be carried out. But this could only be accomplished if proprietary commercial transaction data associated with specific physical lots of wheat were available.

References

Aydin, M. F., U. Ciplak, and M. E. Yucel. "Export Supply and Import Demand Models." The Central Bank of the Republic of Turkey, Research Department Working Paper no. 04/09. pp. 27, 2004.

Bredahl, M. E., W. H. Meyers, and K. J. Collins. "The Elasticity of Foreign Demand for U.S. Agricultural Products: The Importance of the Price Transmission Elasticity." *American Journal of Agricultural Economics* 61(1):58-63, 1979.

Case, J. "On the Form of Market Demand Functions." *Econometrica* January 1974:207-210.

Greene, W. Econometric Analysis, 7th Edition, pp. 1232, Prentice Hall, New Jersey, 2011.

Haniotis, T., J. Baffes, and G. C. W. Ames. "The Demand and Supply of U.S. Agricultural Exports: The Case of Wheat, Corn, and Soybeans." *Southern Journal of Agricultural Economics* December 1988:45-56.

Houck, J. P., and M. E. Ryan. "Market Share Analysis and the International Market for Fats and Oils." University of Minnesota Department of Agricultural Economics Economic Report 78-8, pp. 42, 1978.

Khwaja, S. "The functional form of the aggregate import demand equation: evidence from developing countries." *Pakistan Development Review*, ISSN 0030-9729, 1988.

Konandreas, P., P. Bushnell, and R. Green. "Estimation of Export Demand Functions for U.S. Wheat." Giannini Foundation Research paper no. 496, 1978.

Marsh, T. L. "Elasticities for U.S. Wheat Food Use by Class." Paper presented at Australian Agricultural and Resource Economics Society annual meeting, Fremantle, Western Australia. pp. 35, 2003.

Mohanty, S., and E. W. Peterson. "Estimation of Demand for Wheat by Classes for the United States and European Union." *Agricultural and Resource Economics Review* October 1999: 158-168, 1999.

Mohanty, S., E. W. Peterson, and D. B. Smith. "Estimation of Demand for Wheat by Classes for the United States and European Union." Center for Agricultural and Rural Development Working Paper 97-WP 181. pp. 23, 1997.

Naanwaab, C., and O. Yeboah. "The Impact of NAFTA on Agricultural Commodity Trade: A Partial Equilibrium Analysis." Paper presented at Southern Agricultural Economics Association annual meeting, Birmingham, Alabama, February 4-7, 2012.

Olson, F. and D. M. O'Brien. "Competitive Position and Price Integration of Black Sea Region Wheat." Poster presented at the Joint AAEA and CAES Annual Meeting, Washington, DC., August 4-6, 2013.

Olson, F. and D. M. O'Brien. "The Price Responsiveness of U.S. Wheat Export Demand By Class." Paper presented at the 2012 NCCC-134 Meeting on *Applied Commodity Price Analysis, Forecasting, and Market Risk Management*, St. Louis, Missouri, April 16-17, 2012.

Soltani, M., and S. Saghaian. "Export Demand Function Estimation for U.S. Raisins." Paper presented at Southern Agricultural Economics Association annual meeting, Birmingham, Alabama, February 4-7, 2012.

Taplan, J. H. E. "The Elasticity of Demand for the Exports of a Single Country – A Reconsideration." Australian Journal of Agricultural Economics August 1971:103-108.

Terry, J. T. and T. L. Marsh. "Derived Demand for Wheat by Class." Paper presented at Western Agricultural Economics Association annual meetings, Vancouver, British Columbia, June 29-July 1, 2000. pp. 19.

Thompson, S. R., and M. T. Bohl. "International Wheat Price Transmission and CAP Reform." Paper presented at the AAEA annual meeting, Nashville, Tennessee, July, 1999.

U.S. Wheat Associates (personal communications), U.S. Wheat Associates, Washington, DC.

USDA-WAOB. World Agricultural Supply and Demand Estimates, United States Department of Agricultural World Agricultural Outlook Report, May 9, 2014.

Wilson, W. W, and P. Gallagher. "Quality Differences and Price Responsiveness of Wheat Class Demands." *Western Journal of Agricultural Economics* 15(2, 1990): 254-264.

Wilson, W. W. "Demand for Wheat Classes by Pacific Rim Countries." *Western Journal of Agricultural Economics* 19(1, 1994): 197-209.

Wilson, W., W. Wilson, and B. Dahl. "Protein and the demand for hard wheats." *Australian Journal of Agricultural and Resource Economics*, 53(2009): 285-303.

Table 1. United States' Wheat Classes: Characteristics & Use

Wheat Class	Key Characteristics	Primary End Use
Hard Red Winter (HRW)	Red bran, wide protein range, good gluten strength	Breads, rolls, flat breads, tortillas, cereals & general purpose flour
Hard Red Spring (HRS)	Red bran, high protein, strong gluten strength	Breads, rolls, croissants, bagels & pizza crust
Soft Red Winter (SRW)	Red bran, low protein, weak gluten strength	Cookies, crackers, pretzels, pastries & flat breads
Hard White (HW)	White bran, medium protein	Whole wheat white flour, tortillas, pan bread & flat breads
Soft White (SW)	White bran, low protein, weak gluten strength	Cakes, pastries, snack foods, Asian style noodles & Middle Eastern flat breads
Durum (D)	Red bran, translucent starch, high gluten content	Pasta, couscous & some Mediterranean breads

Table 2. Contract Trade Specifications Used for Wheat & Wheat Flour

Whole Grain (used by farmer, elevator and miller)	**Flour & Baking** (used by miller and baker)
Test Weight	Flour Extraction
Protein	Flour Ash
Moisture	Flour Protein
Shrunken/Broken Kernels	Starch Damage
Foreign Material	Wet Gluten
Total Defects/Damage	Gluten Index
Sour/Musty	Farinograph Absorption
Contrasting Classes	Farinograph Peak Time
Deoxynivalendol (DON) or Vomitoxin	Farinograph Stability
Falling Numbers	Alveograph P, L & W
Vitreous Kernels	Loaf Volume, Crumb Grain & Texture, Loaf Symmetry

Table 3. United States' Wheat Classifications In Comparison to Kazakhstan, Russia & Ukraine

U.S. Class	Kazakhstan	Russia	Ukraine
Hard Red Winter (HRW) (≈40%)	Class 1, 2 & 3 (≈ 33% ? HRW)	Primary crop districts = Southern, Central, Northern Caucasus & Volga (≈ 67% ?? HRW Wheat)	*Mostly Food Uses*: Common Wheat, Group A, Grade 1 & 2 (higher protein) *(>50% HRW Wheat?)*
Hard Red Spring (HRS) (≈25%)	Class 1, 2 & 3 (≈ 67% ? HRS)	Primary crop districts = Siberia, Volga & Urals (≈ 33% ?? HRS Wheat)	
Soft Red Winter (SRW) (≈20%)			*Mostly Feed Uses*: Common Wheat, Group A, Grade 3 & some Group B, Grade 4 & 5 *(<50% SRW?)*
Hard White (HW) (≈1%)			
Soft White (SW) (≈11%)			
Durum (D) (≈3%)	Could not determine classification		Durum Wheat, Grade 1 & 2 *(small amount)*

Table 4. United States' Wheat Classifications In Comparison to Australia, France & Canada

U.S. Class	Australia (also classed by growing zone)	France	Canada
Hard Red Winter (HRW) (≈40%)	Australian Hard by growing region (15-20% HRW-W) (yellow alkaline)	BSP–E,1 (superior bread qual.) BP–E,1 (bread quality) BAF–E,1 (improving wheat)	Canadian Western Red Winter (<5%)
Hard Red Spring (HRS) (≈25%)	Australian Prime Hard (5-10% HRS-W) (yellow alkaline)		Canadian Western Red Spring (≈85%)
Soft Red Winter (SRW) (≈20%)	Australian Soft (<5% SRW Wheat)	BP – 2,3 (bread quality) BB (biscuit baking quality) BAU (other uses)	
Hard White (HW) (≈1%)	Australian Premium White (30-40%), Aust. Premium White Noodle (5-10%), Australian Standard White (20-25%)		
Soft White (SW) (≈11%)	Australian Noodle (<5% SW Wheat)		
Durum (D) (≈3%)	Australian Premium Durum (<5% D)		Canadian Western Red Durum (≈10% Durum)

Table 5. United States' Wheat Classifications In Comparison to Argentina & Germany

U.S. Class	Argentina	Germany
Hard Red Winter (HRW) (≈40%)	Group 1 – Corrector (industrial baking) Group 2 – Traditional (fermentation of > 8 hrs.) Group 3 – Direct Baking (< 8 hr. fermentation) (100% HRW Wheat)	Common Wheat: Elite – E, High Quality – A Normal – B (75%-85% HRW-Wht)
Hard Red Spring (HRS) (≈25%)		
Soft Red Winter (SRW) (≈20%)		Common Wheat: Soft – K (15%-20% SRW-W)
Hard White (HW) (≈1%)		
Soft White (SW) (≈11%)		
Durum (D) (≈3%)		Durum (<5% Durum)

Table 6. World Wheat Export Price Series – For the Black Sea Region, Germany, and Australia

Price Series January 4, 2008 – April 4, 2014	Daily or Weekly	Number of Obs.	Average Price $/bu	Standard Deviation $/bu	Skewness
Black Sea Region – Milling Quality Wheat					
Kazakhstan Milling Wheat (11.5% protein)	Daily	766	$6.79	$1.67	0.01
Novorossiysk, Russia – Milling Wheat (11.5%)	Daily	981	$6.29	$1.44	0.33
Azov Sea Ports, Russia – Milling Wheat (11.5%)	Daily	508	$5.96	$1.34	0.37
Ukraine Milling Wheat (11.5%)	Daily	885	$6.41	$1.59	(0.01)
Kazakhstan Milling Wheat (11.5%)	Weekly	174	$6.78	$1.67	0.05
Novorossiysk, Russia – Milling Wheat (11.5%)	Weekly	235	$6.33	$1.45	0.31
Azov Sea Ports, Russia – Milling Wheat (11.5%)	Weekly	195	$5.63	$1.50	0.65
Ukraine Milling Wheat (11.5%)	Weekly	222	$6.46	$1.56	(0.07)
Ukraine Milling Wheat – 3rd Grade	Weekly	288	$5.48	$1.26	(0.11)
Black Sea Milling Wheat – 3rd Grade	Weekly	185	$6.33	$1.58	0.12
Black Sea Region – Feed Quality Wheat					
Novorossiysk, Russia – Animal Feed	Daily	255	$6.16	$1.34	(0.78)
Azov Sea Ports, Russia – Animal Feed	Daily	189	$4.60	$1.16	0.84
Novorossiysk, Russia – Animal Feed	Weekly	74	$6.08	$1.39	(0.64)
Azov Sea Ports, Russia – Animal Feed	Weekly	82	$4.96	$1.56	0.69
Ukraine "Lower Quality" Wheat	Weekly	293	$4.88	$1.37	(0.35)
Germany – Milling Quality Wheat					
Rostock – "Higher Quality" Wheat	Daily	1,560	$8.34	$1.85	0.24
Rostock – "A" Quality, 13% protein Wheat	Daily	1,552	$7.72	$1.85	0.17
Rostock – "Higher Quality" Wheat	Weekly	322	$8.31	$1.86	0.29
Rostock – "A" Quality, 13% protein Wheat	Weekly	322	$7.70	$1.85	0.18
Hamburg – "A" Quality, 13% protein Wheat	Weekly	145	$8.25	$0.91	0.46
Hamburg – "B" Quality, 12% protein Wheat	Weekly	298	$7.56	$1.78	(0.02)
Koln – Milling Wheat, Delivered	Weekly	234	$7.35	$1.88	(0.12)
Australia – Milling & Feed Quality Wheat (Starting 8/18/2009)					
Albany Western – Hard, 13% min, Track$	**Daily**	**1,103**	**$7.91**	**$1.52**	**0.12**
Albany Western – Hard, 11.5% min, Track$	Daily	1,104	$7.71	$1.42	0.05
Albany Western – Standard White, Track$	Daily	1,104	$7.15	$1.44	0.09
Albany Western – Feed Grade, Track$	Daily	1,085	$6.02	$1.39	0.07
Albany Western – Utility FEED, Track$	Daily	532	$5.72	$1.57	0.65
Albany Western – Hard, 13% min, Track$	Weekly	243	$7.94	$1.54	0.14
Albany Western – Hard, 11.5% min, Track$	Weekly	243	$7.75	$1.45	0.10
Albany Western – Utility FEED, Track$	Weekly	242	$7.34	$1.48	(0.01)
Albany Western – Standard White, Track$	Weekly	243	$7.15	$1.46	0.12
Albany Western – Feed Grade, Track$	Weekly	242	$6.02	$1.38	0.07

Table 7. World Wheat Export Price Series – For the United States, Canada, and Argentina

Price Series January 4, 2008 – April 4, 2014	Daily or Weekly	Number of Obs.	Average Price $/bu	Standard Deviation $/bu	Skewness
United States – Milling Quality Wheat					
U.S. HRS Wheat – FOB	Daily	1,554	$8.22	$2.23	1.81
U.S. HRW Wheat – FOB	Daily	1,552	$7.04	$1.70	0.29
U.S. SRW Wheat – FOB	Daily	1,553	$6.01	$1.53	0.27
U.S. Gulf #2 SRW Wheat	Daily	1,465	$6.92	$1.47	0.08
U.S. HRS Wheat – FOB	Weekly	327	$8.24	$2.23	1.71
U.S. HRW Wheat – FOB	Weekly	327	$7.05	$1.72	0.30
U.S. SRW Wheat – FOB	Weekly	327	$6.03	$1.55	0.28
U.S. Gulf #2 SRW Wheat	Weekly	318	$6.97	$1.51	0.19
U.S. Gulf HRW Wheat – 11.5% Protein	Weekly	135	$7.80	$1.63	(0.21)
Canada – Milling Quality Wheat					
Ontario HRS Wheat – Bid (starting 8/1/2008)	Daily	1,223	$7.28	$1.33	(0.03)
Ontario HRW Wheat – Bid (starting 6/2/2008)	Daily	1,387	$6.05	$1.30	(0.19)
Port Hope, Ontario HRW-W (starting 6/15/09)	Daily	1,017	$6.48	$1.08	(0.24)
Ontario SRW Wheat – Bid (starting 1/4/2008)	Daily	1,404	$5.62	$1.25	(0.09)
Port Hope, Ontario SRW-W (starting 6/15/2009)	Daily	1,017	$5.92	$1.09	(0.44)
Ontario SWW Wheat – Bid (starting 6/2/2008)	Daily	1,365	$5.86	$1.24	(0.11)
Ontario HRS Wheat – Bid (starting 8/1/2008)	Weekly	275	$7.26	$1.34	(0.02)
Port Hope, Ontario HRW-W (starting 6/19/2009)	Weekly	230	$6.42	$1.10	(0.48)
Port Hope, Ontario SRW-W (starting 6/19/2009)	Weekly	232	$5.87	$1.12	(0.41)
Ontario SWW Wheat – Bid (starting 6/6/2008)	Weekly	301	$5.83	$1.25	(0.08)
Thunder Bay Wheat – FOB	Weekly	222	$7.43	$2.05	2.38
Argentina – Milling Quality Wheat					
North Parana Bread Wheat – Warehouse	**Daily**	**1,474**	**$7.15**	**$1.59**	**0.83**
North Parana Bread Wheat – Wholesale	Daily	1,553	$8.07	$1.87	0.86
East Parana Bread Wheat – Warehouse	Daily	1,403	$7.32	$1.56	0.81
East Parana Bread Wheat – Wholesale	Daily	1,549	$8.25	$1.84	0.79
East Parana Wheat – FOB	Daily	1,403	$7.32	$1.56	0.81
SE Parana Bread Wheat – Wholesale	Daily	1,552	$8.18	$1.24	0.84
North Parana Bread Wheat – Warehouse	Weekly	316	$7.14	$1.57	0.85
North Parana Bread Wheat – Wholesale	Weekly	326	$8.07	$1.87	0.85
East Parana Bread Wheat – Warehouse	Weekly	301	$7.31	$1.54	0.83
East Parana Bread Wheat – Wholesale	Weekly	326	$8.25	$1.83	0.78
East Parana Wheat – FOB	Weekly	301	$7.31	$1.54	0.83
SE Parana Bread Wheat – Wholesale	Weekly	326	$8.18	$1.80	0.84

Table 8. Daily Correlation of Selected World Wheat Price Series

	Russia Nvrsk Wht 11.5%	Ukraine Ports Wht 11.5%	Kazakhstan Wheat 11.5%	Australia Hard Wht 13%	U.S. HRW-Wht FOB	U.S. HRS-Wht FOB	U.S. SRW-Wht FOB	GRMNY High-Q Wheat
Russia Nvrsk Wheat 11.5%	**1.00**	0.93	0.70	0.91	0.85	0.76	0.92	0.70
Ukraine Ports Wheat 11.5%	0.93	**1.00**	0.85	0.90	0.90	0.77	0.90	0.85
Kazakhstan Wheat 11.5%	0.70	0.85	**1.00**	0.84	0.67	0.53	0.70	0.93
Australia Hard Wheat 13%	0.91	0.90	0.84	**1.00**	0.88	0.85	0.87	0.84
U.S. HRW-Wheat FOB	0.85	0.90	0.67	0.88	**1.00**	0.90	0.94	0.83
U.S. HRS-Wheat FOB	0.76	0.77	0.53	0.85	0.90	**1.00**	0.82	0.77
U.S. SRW-Wheat FOB	0.92	0.90	0.70	0.87	0.94	0.82	**1.00**	0.86
GRMNY High-Quality Wheat	0.82	0.89	0.75	0.91	0.91	0.86	0.87	**1.00**

Table 9. Weekly Correlation of Selected World Wheat Price Series

	Russia Nvrsk Wht 11.5%	Ukraine Ports Wht 11.5%	Kazakhstan Wheat 11.5%	Australia Hard Wht 13%	U.S. HRW-Wht FOB	U.S. HRS-Wht FOB	U.S. SRW-Wht FOB	GRMNY High-Q Wheat
Russia Nvrsk Wheat 11.5%	1.00	0.94	0.69	0.90	0.84	0.75	0.91	0.82
Ukraine Ports Wheat 11.5%	0.94	1.00	0.82	0.89	0.89	0.77	0.90	0.89
Kazakhstan Wheat 11.5%	0.69	0.82	1.00	0.84	0.71	0.62	0.75	0.75
Australia Hard Wheat 13%	0.90	0.89	0.84	1.00	0.88	0.85	0.87	0.91
U.S. HRW-Wheat FOB	0.84	0.89	0.71	0.88	1.00	0.94	0.94	0.91
U.S. HRS-Wheat FOB	0.75	0.77	0.62	0.85	0.94	1.00	0.82	0.86
U.S. SRW-Wheat FOB	0.92	0.90	0.75	0.87	0.94	0.82	1.00	0.87
GRMNY High-Quality Wheat	0.82	0.89	0.75	0.91	0.91	0.86	0.87	1.00

Table 10. Cointegration Test Results for Selected Weekly World Wheat Price Series

	Russia Nvrsk Wht 11.5%	Ukraine Ports Wht 11.5%	Kazakhstan Wheat 11.5%	Australia Hard Wht 13%	U.S. HRW-Wht FOB	U.S. HRS-Wht FOB	U.S. SRW-Wht FOB	GRMNY High-Q Wheat
Russia Nvrsk Wheat 11.5%	---	**Mixed**	**YES**	**Mixed**	**YES**	**Mixed**	**YES**	**Mixed**
Ukraine Ports Wheat 11.5%	**Mixed**	---	**NO**	NO	Mixed	NO	NO	YES
Kazakhstan Wheat 11.5%	**NO**	**NO**	---	---	---	---	---	---
Australia Hard Wheat 13%	YES	NO	---	---	Mixed	NO	YES	YES
U.S. HRW-Wheat FOB	YES	NO	---	NO	---	NO	Mixed	Mixed
U.S. HRS-Wheat FOB	Mixed	NO	---	Mixed	NO	----	NO	NO
U.S. SRW-Wheat FOB	YES	NO	---	YES	YES	NO	---	NO
GRMNY High-Quality Wheat	Mixed	YES	---	Mixed	NO	NO	NO	---

Figure 1. World Exports of Major Grains – Wheat, Corn and Soybeans

(1960/61 - 2014/15 Marketing Years), Source: USDA PSD Online, May 28, 2014 Custom Query

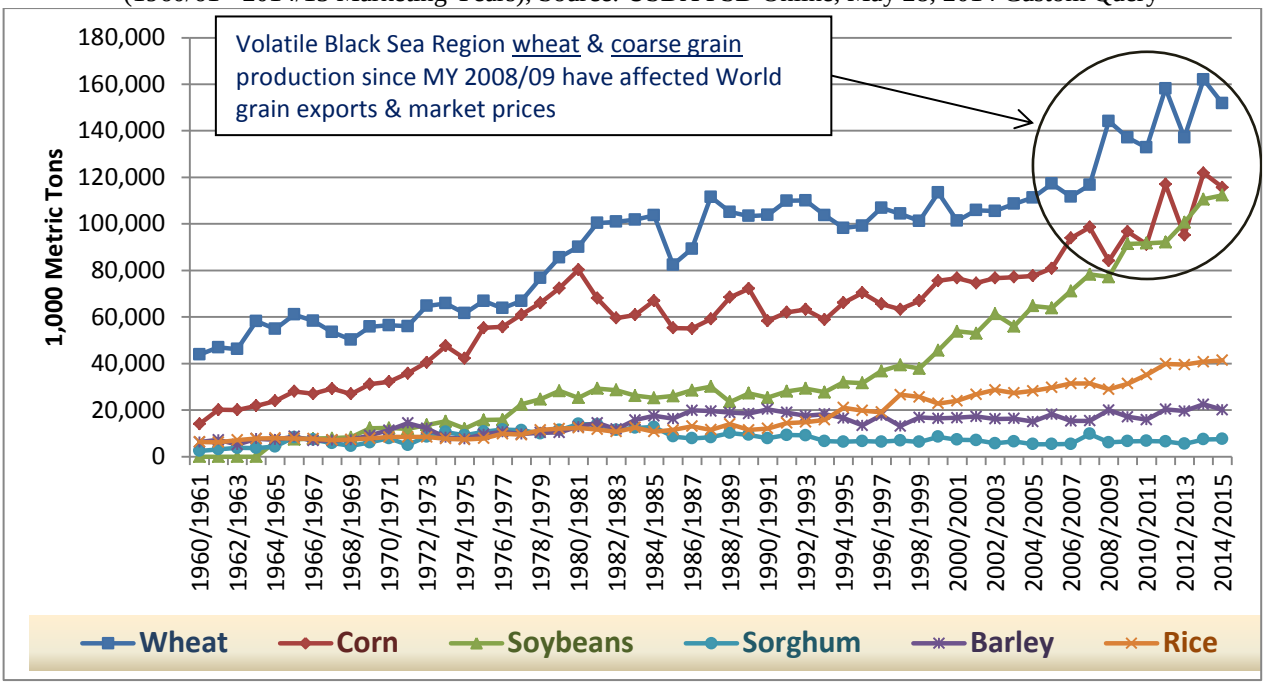

Figure 2. World Daily Wheat Prices – At Key Export Markets

(January 4, 2008 – April 4, 2014), Exchange Rate Adjusted U.S. Dollars per bushel, Source: Bloomberg

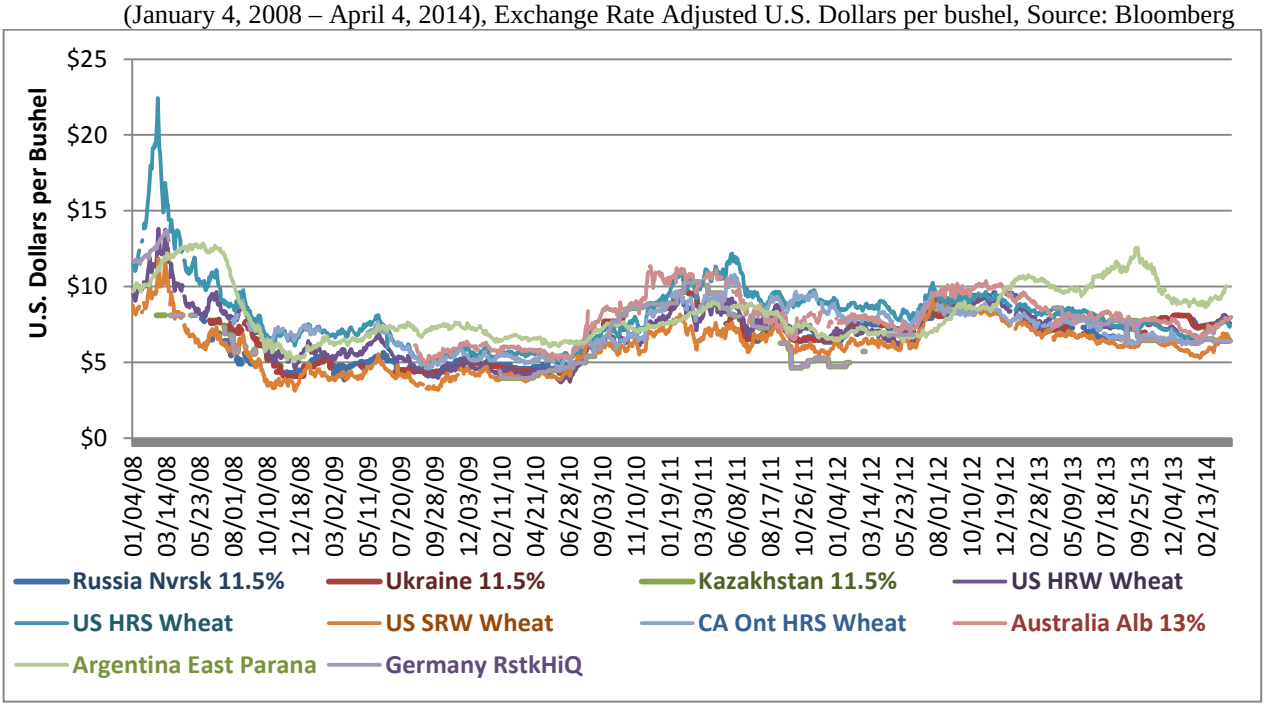

Figure 3. U.S. Hard Red Winter (HRW) Wheat – Top 6 Export Buyers
(2001/02 - 2013/14 Marketing Years), Source: U.S. Wheat Assoc. Commercial Sales Reports, April 17, 2014

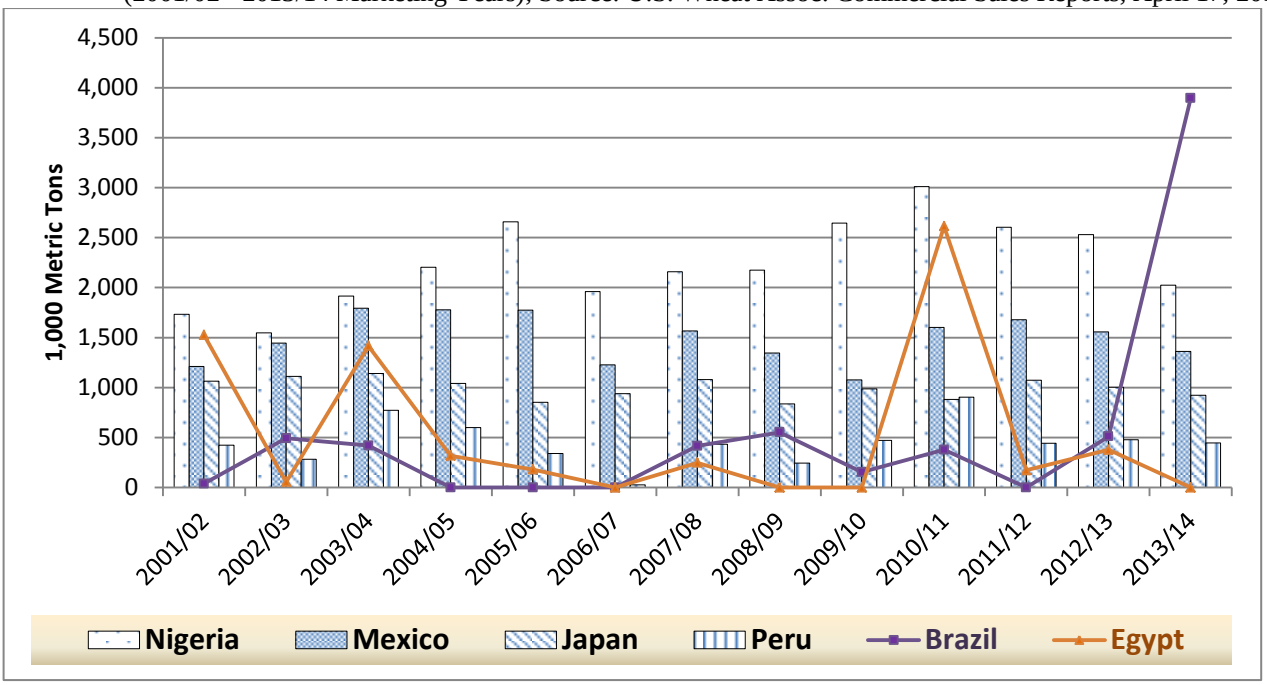

Figure 4. U.S. Hard Red Spring (HRS) Wheat – Top 6 Export Buyers
(2001/02 - 2013/14 Marketing Years), Source: U.S. Wheat Assoc. Commercial Sales Reports, April 17, 2014

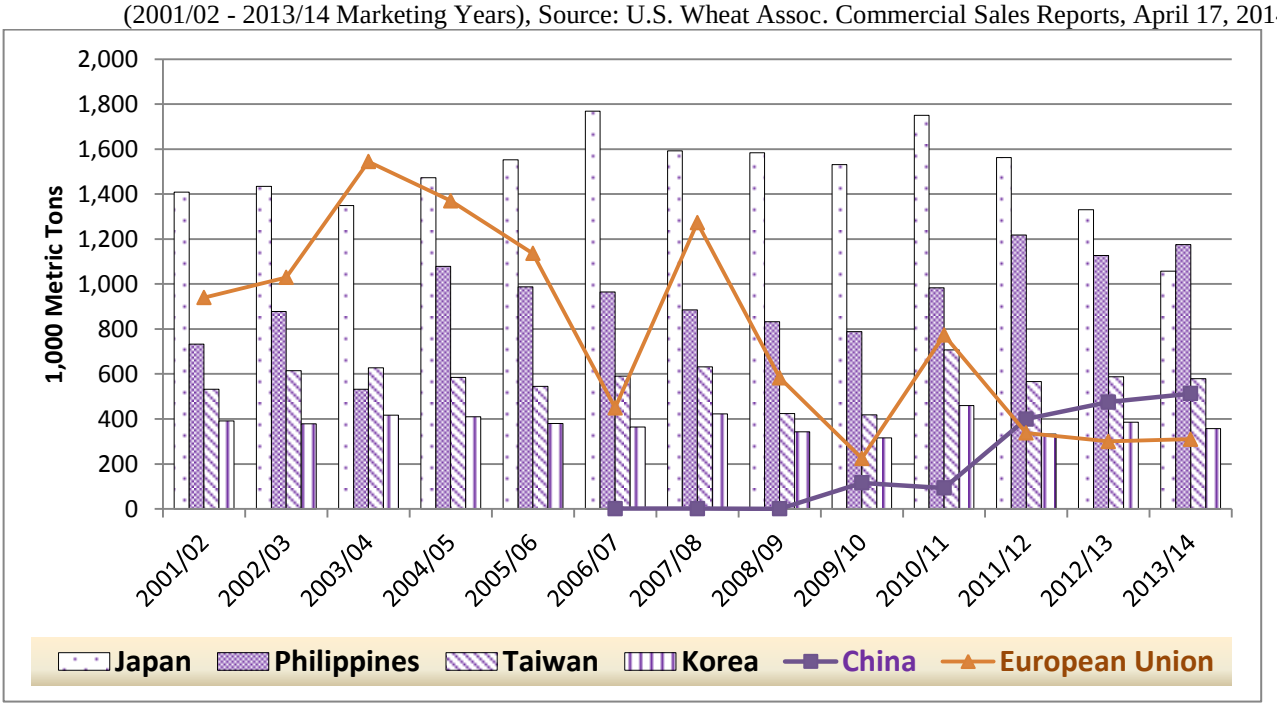

Figure 5. U.S. Soft Red Winter (SRW) Wheat – Top 6 Export Buyers
(2001/02 - 2013/14 Marketing Years), Source: U.S. Wheat Assoc. Commercial Sales Reports, April 17, 2014

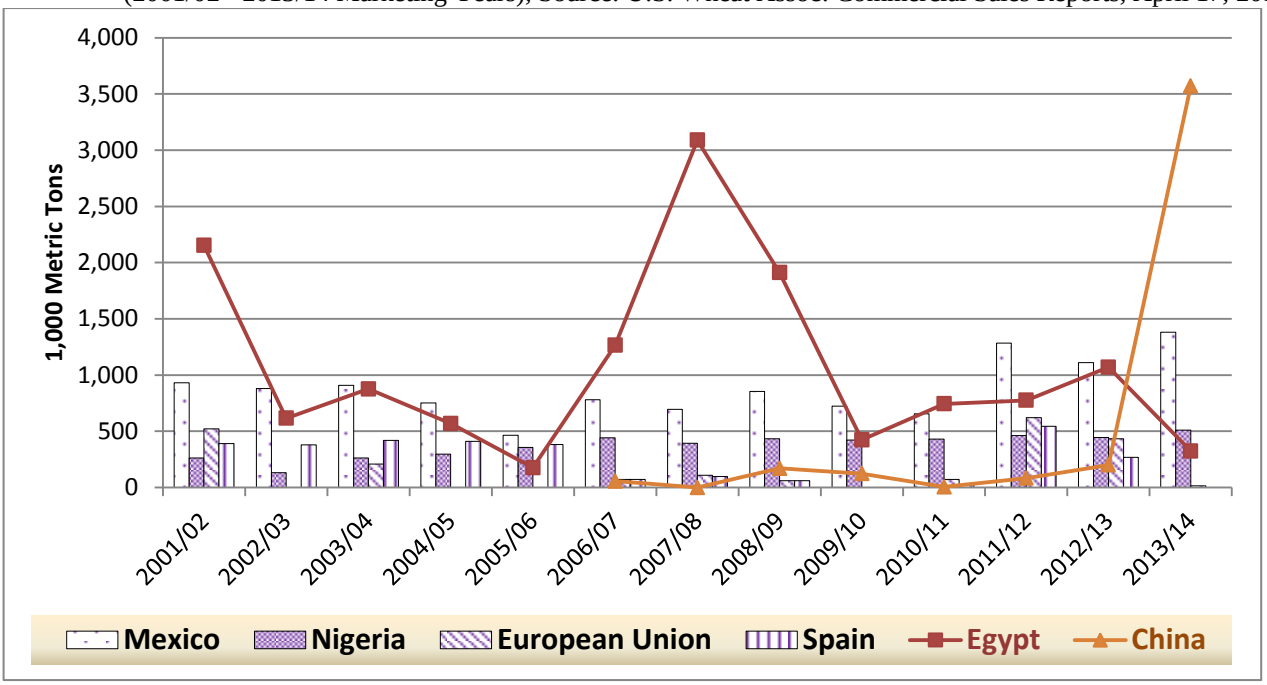

Figure 6. U.S. White (W) Wheat – Top 6 Export Buyers
(2001/02 - 2013/14 Marketing Years), Source: U.S. Wheat Assoc. Commercial Sales Reports, April 17, 2014

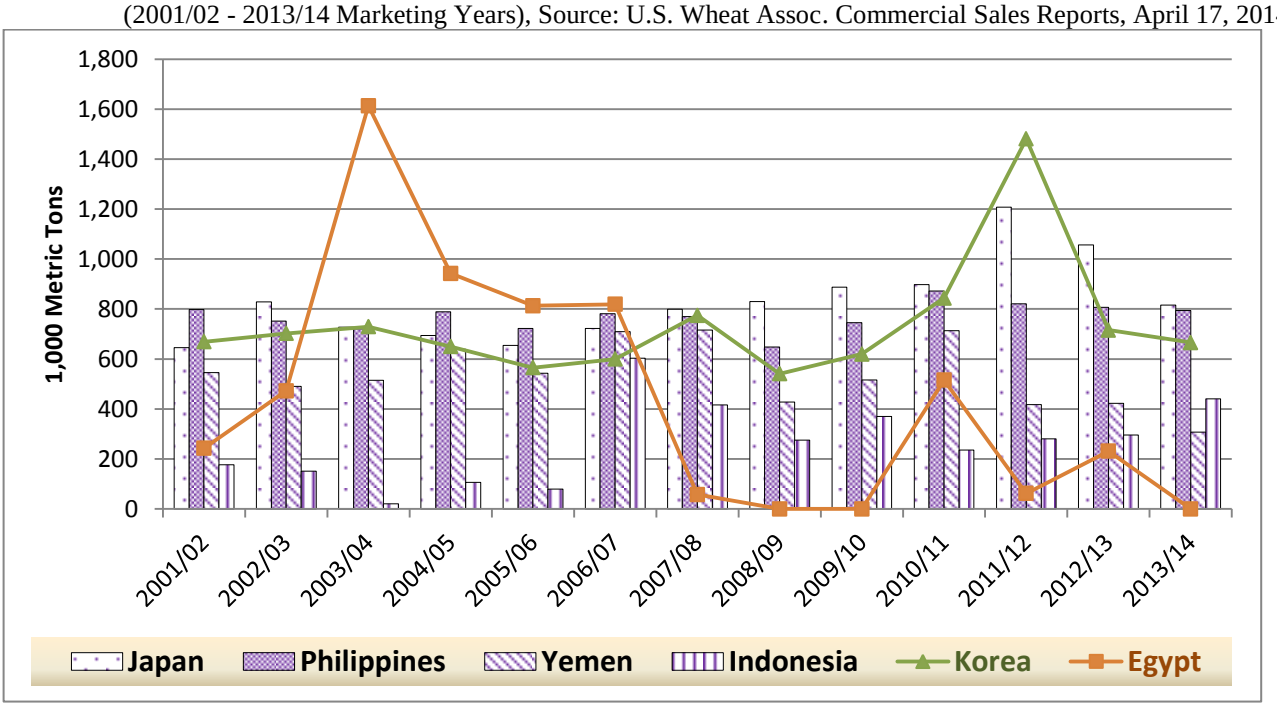

Figure 7. U.S. Durum Wheat – Top 6 Export Buyers

(2001/02 - 2013/14 Marketing Years), Source: U.S. Wheat Assoc. Commercial Sales Reports, April 17, 2014