The Price Responsiveness of U.S. Wheat Export Demand by Class

2012 NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management
St. Louis, Missouri
April 16-17, 2012

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Research Objective

- To analyze factors affecting price responsiveness of U.S. wheat exports by class
- Factors to consider:
  - **Wheat prices** – own $ & cross $ effects from wheat classes & competitive substitutes (i.e., feedgrains at times)
  - **Supply-demand balances by wheat class** for major export sellers & import buyers
  - **Food versus feed quality** wheat supplies by class
  - **Protein / quality factors** of wheat by class
  - **Transportation costs** for U.S. grain export
  - **Exchange rates** for the US Dollar & Other Currencies

Previous Work

- Wilson & Gallagher (WJAE, 1990)
  - "Quality Differences & Price Responsiveness of Wheat Class Demands"
    - Examining factors affecting World market shares by wheat class, along with price responsiveness & substitutability
- Konandreas, Bushnell & Green (WJAE, 1978)
  - "Estimation of Export Demand Functions for U.S. Wheat"
    - How relative U.S. wheat export prices impact U.S. export demand (i.e., U.S. prices vs those in importing countries)
    - Included cross price effects of substitute commodities
    - Aggregated World wheat importing countries by region

Previous Work (more)

- Haniotis, Baffes & Ames (SJAE, 1988)
  - "The Demand & Supply of U.S. Agricultural Exports: The Case for Wheat, Corn & Soybeans"
    - Used a dynamic system of export supply & demand equations
    - Useful info on data sources & forming a World wheat price index
- Naanwaab & Yeboah (SAEA Meetings, 2012)
  - "The Impact of NAFTA on Agricultural Commodity Trade: A Partial Equilibrium Analysis"
    - Use of quarterly grain supply-demand data; relative commodity prices; partial equilibrium analysis; & functional form issues
    - Focused on impact on trade between countries (Mexico, Canada, U.S.)

U.S. Wheat Classes

- **Hard Red Winter Wheat (HRWW)**
  - 55% (616 mb) of U.S. wheat exports in MY 2010/11
  - A major U.S. HRWW export competitor – Argentina
  - A hard, brownish, mellow high-protein wheat
    - Used for bread, hard baked goods; & also with other flours to increase protein in pastry flour for pie crusts
- **Hard Red Spring Wheat (HRSW)**
  - 30% (339 mb) of U.S. wheat exports in MY 2010/11
  - A major U.S. HRSW export competitor – Canada
  - Hard, brownish, high-protein wheat
    - Used for bread & hard baked goods

U.S. Wheat Classes (more)

- **Soft Red Winter Wheat (SRWW)**
  - 10% (109 mb) of U.S. wheat exports in MY 2010/11
  - Major U.S. SRWW Export Competitors – Europe, elsewhere
  - High yielding, low-protein wheat
    - Used for flat breads, cakes, pastries, and crackers
- **Hard & Soft White Wheat (WW)**
  - 8% (95 mb) of U.S. wheat exports in MY 2010/11
  - A major U.S. White Wheat export competitor – Australia
  - Hard white wheat (HWW): hard, light-colored, opaque, chalky, medium-protein wheat planted in dry, temperate areas
  - Soft white wheat (SWW) is a soft, light-colored, very low protein wheat grown in temperate, moist areas

Two Types of Export Models Used

A. Export Competitor Models

- Exports of U.S. grains ÷ major competitor's
- Prices of U.S. grains ÷ major competitor's
- *Issue: How do relative prices & other factors affect the exports of the U.S. versus those of individual competitors?*

B. World Export Share Models

- Exports of U.S. grains ÷ World exports
- Prices of U.S. grains ÷ World prices
- *Issue: How do relative prices & other factors affect the market share of the U.S. versus World exports?*

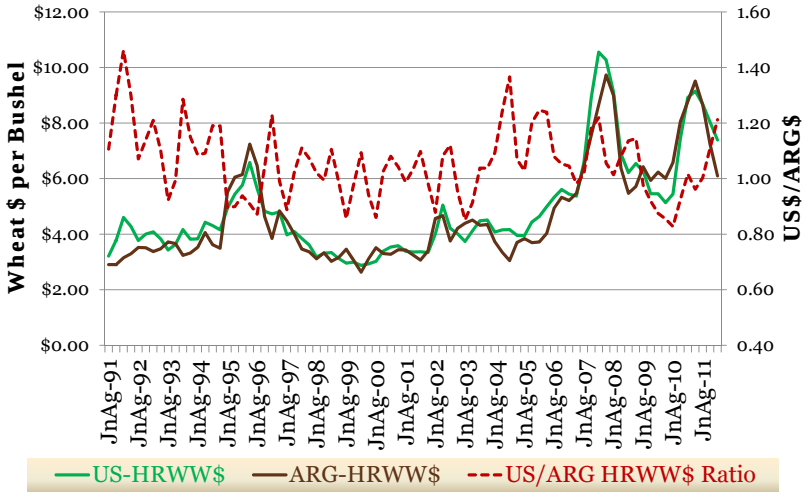
U.S. Data Available (Source: USDA)

- U.S. Exports
  - **Wheat:** HRW, HRW, White, SRW – months/qtrs. since 1973
  - **Corn:** months/quarters since 1975
- U.S. Export Prices
  - **HRW Wheat** – Texas Gulf #1 (since 1991)
  - **HRS Wheat** – Pacific NW, DNS 14% protein (since 1991)
  - **SRW Wheat** – Louisiana Gulf #2 (since 1988)
  - **SWW Wheat** – Portland #1 (since 1973)
  - **Corn** – Louisiana Gulf Ports, Yellow #1 (since 1975)
- Ocean Freight Costs for Shipping Grain
  - Shipping rates from Gulf & Pacific NW to Japan (since 1996)

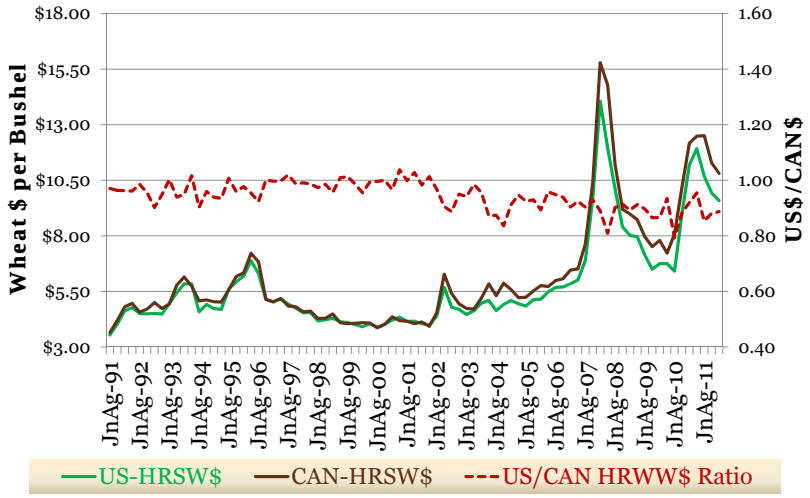
Foreign Data Available (Sources: USDA, IGC)

- Exports – Available since at least 1991 by Marketing Year
  - Argentina Wheat (HRWW)
  - Canada Wheat (HRSW)
  - Australia Wheat (SWW)
  - Argentina Corn
- World Prices – All available since at least 1991 by Quarter
  - **HRW Wheat** – Argentina HRW #2
  - **HRS Wheat** – Canada western HRS #1
  - **SRW Wheat** – No continuous series readily available (***)
  - **SWW Wheat** – Australia SWW
  - **Corn** – Argentina Maize @ UpRiver Markets

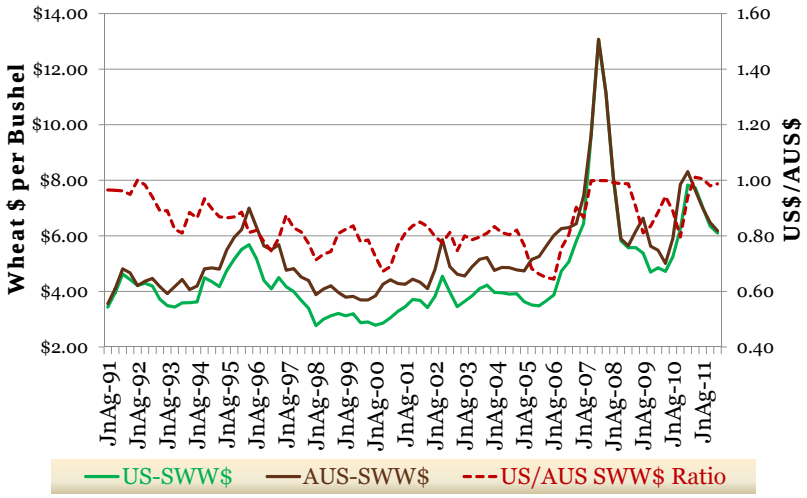
U.S. & Argentina HRWW Prices



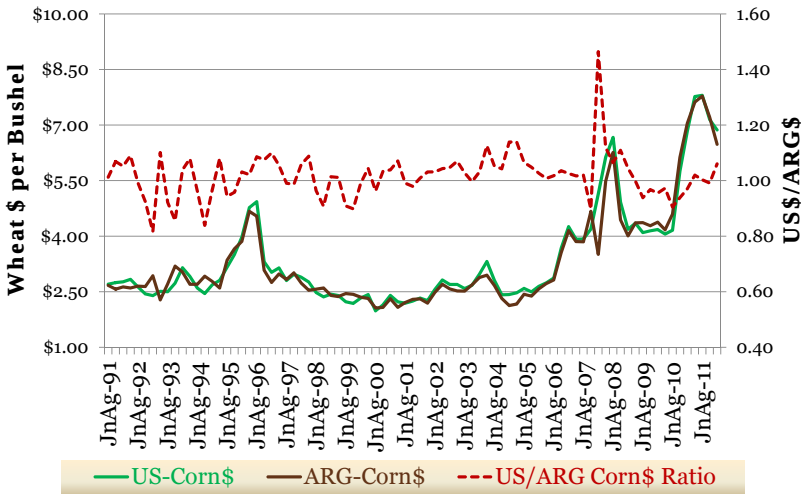
U.S. & Canada HRSW Prices



U.S. & Australia SWW Prices



U.S. & Argentina Corn Prices



Wheat / Corn Market Quarters

- **Wheat Quarters** per Marketing Year (June ➲ May)
  - Qtr#1: June-August
  - Qtr#2: September-November ⇨ DV (0/1) = wQtr2(1)
  - Qtr#3: December-February ⇨ DV (0/1) = wQtr3(1)
  - Qtr#4: March-May ⇨ DV (0/1) = wQtr4(1)
- **Corn Quarters** per Mktg. Year (September ➲ August)
  - Qtr#1: September-November
  - Qtr#2: December-February ⇨ DV(0/1) = cQtr2(1)
  - Qtr#3: March-May ⇨ DV(0/1) = cQtr3(1)
  - Qtr#4: June-August ⇨ DV(0/1) = cQtr4(1)

A1. Export Competitor Variables (ex. HRWW)

- Export Ratio: $$Expt^{HRWW}_{US/ARG} = \frac{Expt^{HRWW}_{US,Yr(i),Qtr(j)}}{Expt^{HRWW}_{ARG,MktgYr(i),Estimate\_Qtr(j)}}$$
- Price Ratio: $$\Pr^{HRWW}_{US/ARG} = \frac{\Pr^{HRWW}_{US,Yr(i),Qtr(j)}}{\Pr^{HRWW}_{ARG,Yr(i),Qtr(j)}}$$
- Ending Stocks-to-Use: $$SU^{Wheat/Corn}_{Wld} = \frac{Ending\_Stocks^{Wheat/Corn}_{World,Yr(i),Qtr(j)}}{Total\_Use^{Wheat/Corn}_{World,Yr(i),Qtr(j)}}$$
- Ocean Freight: $$Freight^{HRWW}_{US-Destn} = \frac{Ocean\_Freight^{HRWW}_{USGulf-to-Japan,Yr(i),Qtr(j)}}{Ocean\_Freight^{HRWW}_{USGulf-to-Japan,1996,Qtr\#3(Dec-Feb)}}$$

A2. U.S. Competitor Export Models

- Exports$^{US/Other}$ = f (Price$^{US/Other}$, Stks/Use, USD$, Freight, Qtrs)
- Hard Red Winter Wheat (HRWW)

$$Expt^{HRWW}_{US/ARG} = f\left(\Pr^{HRWW}_{US/ARG}, \Pr^{HRSW}_{US/CAN}, \Pr^{SWW}_{US/AUS}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{WldTrade}_{USD\$}, Freight^{HRWW}_{US-Destn}, Qtrs^{Wheat}_{2-4}\right)$$

- Hard Red Spring Wheat (HRSW)

$$Expt^{HRSW}_{US/CAN} = f\left(\Pr^{HRSW}_{US/CAN}, \Pr^{HRWW}_{US/ARG}, \Pr^{SWW}_{US/AUS}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{CAN\$}_{USDollar}, Freight^{HRS-W}_{US-Destn}, Qtrs^{Wheat}_{2,3,4}\right)$$

- Soft White Wheat (SWW)

$$Expt^{SWW}_{US/AUS} = f\left(\Pr^{SWW}_{US/AUS}, \Pr^{HRWW}_{US/ARG}, \Pr^{HRSW}_{US/CAN}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{AUS\$}_{USDollar}, Freight^{SWW}_{US-Destn}, Qtrs^{Wheat}_{2-4}\right)$$

- Corn

$$Expt^{Corn}_{US/ARG} = f\left(\Pr^{Corn}_{US/ARG}, SU^{Corn}_{Wld}, SU^{Wheat}_{Wld}, \$Exch^{WldTrade}_{USDollar}, Freight^{Corn}_{US-Destn}, Qtrs^{Corn}_{2-4}\right)$$

B1. World Export Share Variables (ex. HRWW)

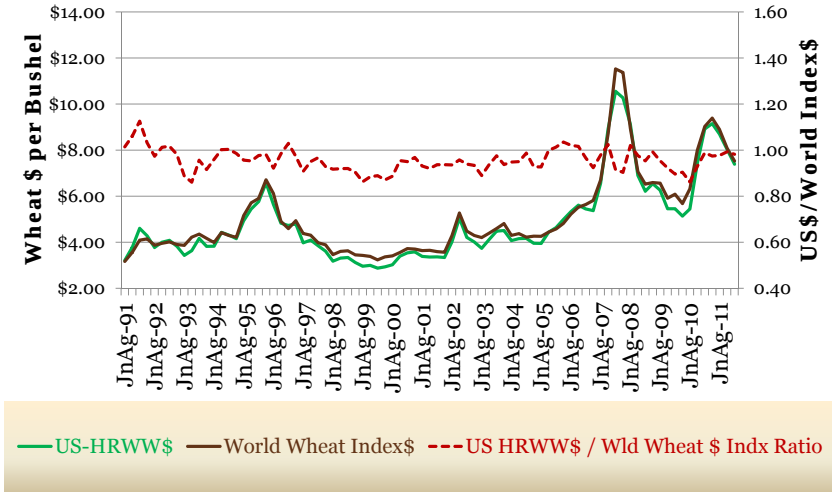
- Export Ratio:

$$Expt^{HRWW}_{US/Wld} = \frac{Expt^{HRWW}_{US,Yr(i),Qtr(j)}}{(Expt \div 4)^{All\_Wheat}_{World,Estimate-MktgYr(i),Qtr(j)}}$$

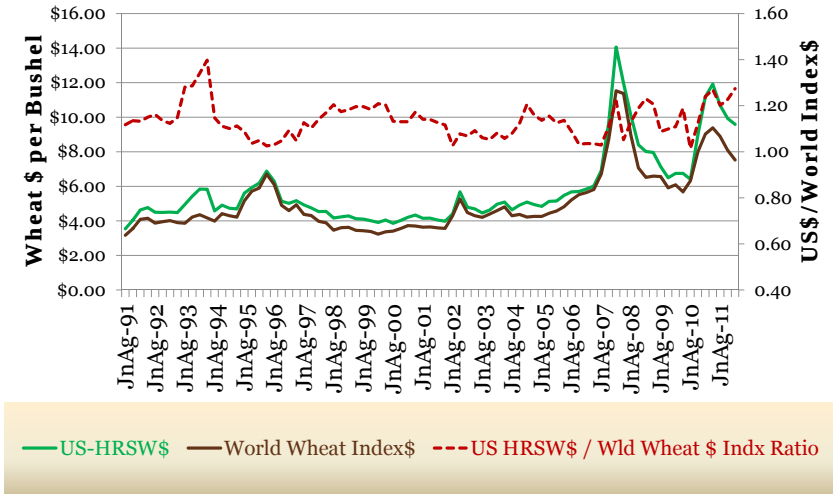
- Price Ratio:

$$Pr^{HRWW}_{US/Wld} = \frac{Pr^{HRWW}_{US,Yr(i),Qtr(j)}}{Pr^{World\_Wheat}_{Avg(USWht+ARG+CAN+AUS),Yr(i),Qtr(j)}}$$

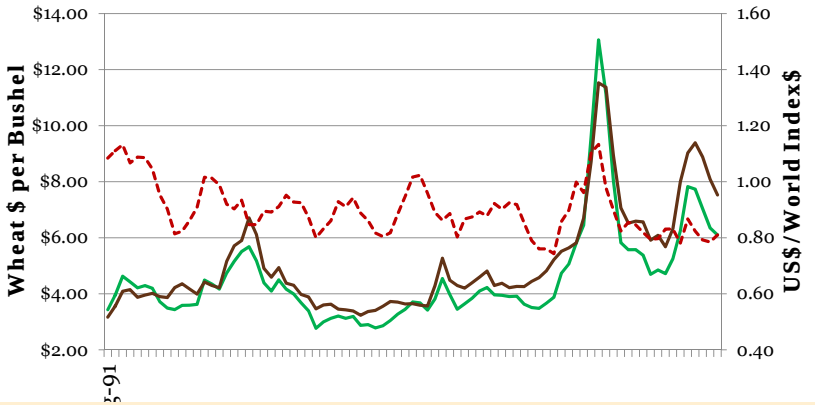
U.S. HRWW & World Avg Wheat $'s



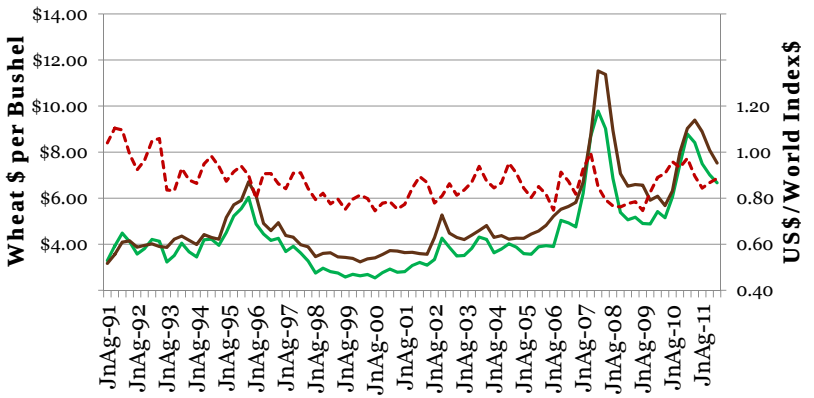
U.S. HRSW & World Avg Wheat $'s



U.S. SWW & World Avg Wheat $'s



U.S. SRWW & World Avg Wheat $'s



B2. U.S. World Export Share Models

- $Exports^{US/World} = f(Price^{US/World}, Stks/Use, USD\$, Freight, Qtrs)$
- Hard Red Winter Wheat (HRWW)

$$Expt^{HRWW}_{US/Wld} = f\left(Pr^{HRWW}_{US/Wld}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{WldTrade}_{USD\$}, Freight^{HRWW}_{US-Destn}, Qtrs^{Wheat}_{2-4}\right)$$

- Hard Red Spring Wheat (HRSW)

$$Expt^{HRSW}_{US/Wld} = f\left(Pr^{HRSW}_{US/Wld}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{WldTrade}_{USDollar}, Freight^{HRSW}_{US-Destn}, Qtrs^{Wheat}_{2,3,4}\right)$$

- Soft White Wheat (SWW)

$$Expt^{SWW}_{US/Wld} = f\left(Pr^{SWW}_{US/Wld}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{WldTrade}_{USDollar}, Freight^{SWW}_{US-Destn}, Qtrs^{Wheat}_{2-4}\right)$$

- Soft Red Winter Wheat (SRWW)

$$Expt^{SRWW}_{US/Wld} = f\left(Pr^{SRWW}_{US/Wld}, SU^{Wheat}_{Wld}, SU^{Corn}_{Wld}, \$Exch^{WldTrade}_{USDollar}, Freight^{SRWW}_{US-Destn}, Qtrs^{Wheat}_{2-4}\right)$$

U.S. Hard Red Winter Wheat (log-log fnl form)

A.U.S. Competitor Model 1991-Q1 to 2012-Q3			B. U.S. Market Share Model 1996-Q3 to 2012-Q3		
Variable	Coeff.	t-stat (p-value)	Variable	Coeff.	t-stat (p-value)
Intercept	*9.02	9.01 (0.00)	Intercept	(3.14)	(1.37) (0.18)
$Pr\$_{US/Arg}^{HRWW}$	*(1.07)	(2.77) (0.01)	$Pr\$_{US/Wld}^{HRWW}$	*(1.83)	(2.12) (0.04)
$Pr\$_{US/Can}^{HRSW}$	*(2.89)	(3.13) (0.00)	SU_{Wld}^{Wheat}	(0.38)	(1.47) (0.15)
$Pr\$_{US/Aus}^{SWW}$	0.56	1.18 (0.24)	SU_{Wld}^{Corn}	(0.40)	(1.70) (0.10)
SU_{Wld}^{Wheat}	0.39	1.16 (0.25)	$USD\$_{WldTrade}$	0.70	1.65 (0.10)
SU_{Wld}^{Corn}	0.02	0.09 (0.93)	$Freight^{HRWW}$	*0.16	2.25 (0.03)
$USD\$_{TradePtnrs}$	*(1.02)	(5.71) (0.00)	wQ2 (Sep-Nov)	(0.07)	(0.69) (0.49)
			wQ3 (Dec-Feb)	*(0.23)	(2.23) (0.03)
			wQ4 (Mar-May)	(1.89)	(1.86) (0.07)
F = 10.86 / 0.00 sig; $AdjR^2$ = 0.38			F = 3.30/ 0.00 sig; $AdjR^2$ = 0.22		

U.S. Hard Red Spring Wheat (log-log fnl form)

A.U.S. Competitor Model 1991-Q1 to 2012-Q3			B. U.S. Market Share Model 1991-Q1 to 2012-Q3		
Variable	Coeff.	t-stat (p-value)	Variable	Coeff.	t-stat (p-value)
Intercept	*1.93	4.41 (0.00)	Intercept	*19.10	5.34 (0.00)
$Pr\$_{US/Arg}^{HRSW}$	*(1.61)	(2.07) (0.04)	$Pr\$_{US/Wld}^{HRSW}$	*(8.35)	(2.65) (0.01)
SU_{Wld}^{Wheat}	(0.05)	(0.21) (0.83)	SU_{Wld}^{Wheat}	(0.67)	(0.09) (0.93)
SU_{Wld}^{Corn}	(0.01)	(0.07) (0.94)	SU_{Wld}^{Corn}	3.47	0.46 (0.65)
$Exchg_{Can\$/US\$}$	0.38	1.29 (0.20)	$USD\$_{WldTrade}$	*(0.04)	*(4.54) (0.00)
wQ2 (Sep-Nov)	0.38	3.41 (0.93)	$Freight^{HRSW}$	na	na
wQ3 (Dec-Feb)	0.09	0.96 (0.34)	wQ2 (Sep-Nov)	*2.50	4.24 (0.00)
wQ4 (Mar-May)	*0.19	2.03 (0.05)	wQ3 (Dec-Feb)	*1.27	2.12 (0.04)
			wQ4 (Mar-May)	*1.52	2.53 (0.01)
F = 2.34 / 0.03 sig; $AdjR^2$ = 0.10			F = 6.02/ 0.00 sig; $AdjR^2$ = 0.30		

U.S. White Wheat (log-log fnl form)

A.U.S. Competitor Model 1996-Q3 to 2012-Q3			B. U.S. Market Share Model 1991-Q1 to 2012-Q3		
Variable	Coeff.	t-stat (p-value)	Variable	Coeff.	t-stat (p-value)
Intercept	(0.10)	(0.15) (0.88)	Intercept	*1.00	1.95 (0.05)
$Pr\$_{US/AUS}^{SWW}$	(0.07)	(0.18) (0.86)	$Pr\$_{US/Wld}^{SWW}$	(0.24)	(0.81) (0.42)
SU_{Wld}^{Wheat}	*(0.54)	(2.13) (004)	SU_{Wld}^{Wheat}	*(0.67)	(2.88) (0.01)
SU_{Wld}^{Corn}	*(0.62)	(2.70) (0.01)	SU_{Wld}^{Corn}	*(0.29)	(2.06) (0.04)
$Exchg_{AUS\$/US\$}$	(0.12)	(0.43) (0.67)	$USD\$_{WldTrade}$	*(2.01)	(2.16) (0.03)
$Freight^{SWW}$	0.01	0.09 (0.93)	$Freight^{SWW}$	na	na
wQ2 (Sep-Nov)	*0.34	3.45 (0.00)	wQ2 (Sep-Nov)	*0.31	4.71 (0.00)
wQ3 (Dec-Feb)	*0.25	2.54 (0.01)	wQ3 (Dec-Feb)	*0.22	3.36 (0.00)
wQ4 (Mar-May)	0.12	1.27 (0.21)	wQ4 (Mar-May)	0.10	1.43 (0.16)
F = 5.16 / 0.00 sig; $AdjR^2$ = 0.34			F = 7.64/ 0.00 sig; $AdjR^2$ = 0.36		

U.S. Soft Red Winter Wheat (log-log fnl form)

A.U.S. Competitor Model			B. U.S. Market Share Model 1991-Q1 to 2012-Q3		
Variable	Coeff.	t-stat (p-value)	Variable	Coeff.	t-stat (p-value)
na	na	na	Intercept	0.55	0.44 (0.66)
			$Pr\$_{US/Wld}^{SRWW}$	(0.21)	(0.24) (0.81)
			SU_{Wld}^{Wheat}	(0.68)	(1.67) (0.10)
			SU_{Wld}^{Corn}	(0.29)	(0.92) (0.36)
			$USD\$_{WldTrade}$	(0.13)	(0.54) (0.59)
			$Freight^{SRWW}$	na	na
			wQ2 (Sep-Nov)	(0.14)	(0.91) (0.37)
			wQ3 (Dec-Feb)	*(0.46)	(2.77) (0.01)
			wQ4 (Mar-May)	*(0.42)	(2.63) (0.01)
			F = 2.92/ 0.01 sig; $AdjR^2$ = 0.14		

U.S. Corn (log-log functional form)

A1.U.S. Competitor Model 1991-Q1 to 2012-Q3			B. U.S. Market Share Model		
Variable	Coeff.	t-stat (p-value)	Variable	Coeff.	t-stat (p-value)
Intercept	*7.01	9.71 (0.00)	na	na	na
$Pr\$_{US/Arg}^{Corn}$	(0.76)	(1.69) (0.10)			
SU_{Wld}^{Corn}	0.32	1.60 (0.11)			
SU_{Wld}^{Wheat}	*(0.87)	(3.44) (0.00)			
$USD\$_{WldTrade}$	*(0.59)	(5.22) (0.00)			
$Freight^{Corn}$	na	na			
F = 11.45 / 0.00 sig; $AdjR^2$ = 0.34					

Work To Do

1) Develop a World Corn Price Index to extend model
2) Systems estimation of these individual equations
   - Next step is to place these individual Wheat Class & Corn export equations into a system of equations – using methods such as Seemingly Unrelated Regressions (SUR)
     - Elasticity / flexibility measures from individual equations may tend to be less than those from equation systems
3) Rethink model structures & functional forms
   - How can one better represent U.S./World wheat market interactions on a class-by-class basis?

Observations re: Study Results

1) Own price responsiveness of U.S. exports found in HRWW & HRSW (2 largest U.S. wheat export classes)
   - Interaction between U.S. HRWW & HRSW exports
     - Varying protein of U.S. HRWW impacts HRSW demand

2) "Secondary" nature of U.S. White & SRWW exports
   - Reduction in U.S. White & SRW wheat exports occur when World wheat & corn supplies are more abundant
     - Is the U.S. a "fall back" supplier of White & SRW wheat exports when the World is in short supply of wheat &/or corn? (Yes - DOB)

Observations (more)

3) Are the primary ports for the two available HRSW price series (U.S. & Canada) close enough together that Ocean Freight costs are essentially equal? (Seemingly Yes-DOB)

4) A grain exporter's relative geographic location determines how important freight costs are to their market competiveness
   - **Examples**: World vs Black Sea wheat; U.S. vs Australia wheat (?); U.S. vs South American crops (?); etc., etc.

Observations (still more)

5) The small # of publically available grain price series limits this type of international ag export analysis
   - Commercial grain traders deal with such international cash price series daily, but that Q&P info is generally not public
     - **Question**: Do ag economists need to develop more public international grain Qty-Pr$ series than USDA-IGC now offers?

6) Limited World Wheat/Grain Export Data by Wheat Class & by periods less than a Marketing Year
   - Monthly or Quarterly wheat data are generally not publically available from many foreign countries
     - Forces market analysts & researchers to presume broad country-by-country aggregation of wheat varieties by class

Questions?

Comments?

Suggestions?