Grain Marketing: Getting Back to the Fundamentals

Darrel L. Good
Scott H. Irwin

http://www.farmdoc.uiuc.edu/
Forecasting in Agriculture

Consider, this information for Illinois farmers over 1975-2001

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average price</td>
<td>$2.16/bu.</td>
<td>$5.85/bu.</td>
</tr>
<tr>
<td>66\textsuperscript{th} percentile</td>
<td>$2.44/bu.</td>
<td>$6.25/bu.</td>
</tr>
<tr>
<td>Revenue gain</td>
<td>$39.99/acre</td>
<td>$17.68/acre</td>
</tr>
</tbody>
</table>
Fundamental Analysis

• Definition: An assessment of price based on the underlying supply and demand factors and the changes in those relationships

• Motivated by economic theory of supply and demand
  – The task of the market is to establish a price that will “clear” the market

• Fundamental analysis can be thought of as the process of anticipating the market clearing price
Fundamental Analysis

- Techniques: Subjective judgement to sophisticated statistical models
- Goal: Estimate “fundamental value” and compare to market price
  - Bullish: Value > Price
  - Bearish: Value < Price
Price Making Forces in the Corn Market

- Acreage
- Yield
- Weather
- Exchange rates
- Consumer income
- Government policies
- Foreign grain production
- Livestock numbers
- Interest rates
- Consumer income
- Feeding rates
- Livestock prices
- Trade agreements
- World economic growth
Balance Sheets

- Most popular tool used in fundamental analysis of crop prices
- Unit of analysis is a marketing year
- Constructed for a particular country, region or the entire world
  - Build supply side first
  - Then build consumption, or use, side
  - Price ties both sides together by rationing available supplies to competing uses
Economic Model Underlying Balance Sheets

![Graph showing demand and supply relationship with price P₀ and quantity Q₀.](image)
## Balance Sheet Format for Corn

<table>
<thead>
<tr>
<th>Beginning Stocks</th>
<th>+ Production</th>
<th>+ Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>= Total Supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed and Residual</td>
<td>+ Food, Seed and Industrial</td>
<td>+ Exports</td>
</tr>
<tr>
<td>= Total Consumption (Use)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ending Stocks = Total Supply – Total Consumption</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Balance Sheet Format for Soybeans**

<table>
<thead>
<tr>
<th>Beginning Stocks</th>
<th>+ Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ Imports</td>
</tr>
<tr>
<td></td>
<td>= Total Supply</td>
</tr>
<tr>
<td>Crush</td>
<td>+ Exports</td>
</tr>
<tr>
<td></td>
<td>+ Food, Seed and Residual</td>
</tr>
<tr>
<td></td>
<td>= Total Consumption (Use)</td>
</tr>
<tr>
<td>Ending Stocks</td>
<td>= Total Supply – Total Consumption</td>
</tr>
</tbody>
</table>
Forecasting Calendar for 2004/2005 Corn Balance Sheets

- Fall 2003: First forecasts of supply and use for 2004-2005 marketing year
  - Typically based on trend forecasts, recent history and basic economic relationships
- Spring 2004: Update supply forecasts based on USDA acreage surveys
- Summer 2004: Update supply forecasts based on weather and USDA crop reports
Forecasting Calendar for 2004/2005 Corn Balance Sheets

• Fall 2004-Summer 2005:
  – Continue to update supply forecasts based on USDA crop reports (Aug-Nov, Jan)
  – Update use forecasts based on:
    • Export sales and inspections reports
    • Quarterly USDA stock estimates
    • Livestock numbers
    • Monthly processing reports
WASDE Balance Sheet Estimates from the USDA

- WASDE: World Agricultural Supply and Demand Estimates
- Cover all major commodities
- Separate balance sheets maintained for over 90 countries!
- Numerous agencies within USDA participate in “consensus” process
- Serve as the benchmark balance sheet estimates for nearly all market participants
Constructing Early Season 2004/2005 Balance Sheets for Corn

• The first WASDE estimates will not be released until May 2004
• We will use simple trend projections and last year’s values as our starting point
## Balance Sheet Format for Corn

<table>
<thead>
<tr>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning Stocks</td>
<td>( \text{Beginning Stocks} + \text{Production} + \text{Imports} ) = \text{Total Supply}</td>
</tr>
<tr>
<td>Feed and Residual</td>
<td>( \text{Feed and Residual} + \text{Food, Seed and Industrial} + \text{Exports} ) = \text{Total Consumption (Use)}</td>
</tr>
<tr>
<td>Ending Stocks</td>
<td>( \text{Ending Stocks} = \text{Total Supply} - \text{Total Consumption} )</td>
</tr>
<tr>
<td>Price</td>
<td>( \text{Price} = ??? )</td>
</tr>
</tbody>
</table>

- Ending Stocks is calculated as the difference between Total Supply and Total Consumption (Use).
Ending Stocks and Price

• Ending stocks indicate the relative balance between supply and demand
  – Ending stocks high, price low
  – Ending stocks low, price high

• Relationship between ending stocks and price is often used to forecast prices
Corn Ending Stocks and Price, 1975/76-2003/04*

Source: USDA

*2003/04 Projected
US Corn Ending Stocks/Total Use, 1975/76-2003/04*

Source: USDA

*2003/04 Projected
Graphical View of Corn Market
Adding Shifter Variables

• In the simple model, there is only one equilibrium because nothing ever changes!

• In reality, we know that:
  – Demand curves shift due to changes in the price of substitutes, income and other variables
  – Supply curves shift due to changes in the price of inputs, technology and other variables

• Key point: Changing equilibrium prices and quantities are driven by changes in the level of “shifter variables”
Graphical View of Model with a Single Demand Shifter (Income)

Graphical representation of demand and supply with two levels of income (I_t). The demand shifter (Income) affects the demand curve, leading to different quantities demanded at each price level. The graph shows:

- Price axes labeled with $P_{1t}$ and $P_{2t}$
- Quantity axes labeled with $Q_{1t}$ and $Q_{2t}$
- Supply curve labeled $Q_{S_t}$
- Demand curves labeled $Q_{D_t} (I_t \text{ level 1})$ and $Q_{D_t} (I_t \text{ level 2})$
Model with A Demand Shifter (Income) and Supply Shifter (Fertilizer Price)
Corn Price and Ending Stocks/Use, 1975/76-2003/04*

Source: USDA

*2003/04 Projected
Corn Price and Ending Stocks/Use, 1975/76-2003/04: Linear Model*

\[ y = -0.0104x + 2.5865 \]

\[ R^2 = 0.159 \]

Source: USDA  
*2003/04 Projected
Logical Characteristics of Relationship Between Price and Stocks

- As ending stocks approach zero, theoretically, there is no upper limit for price.
- As ending stocks get very large, price is unlikely to go below some minimum “reservation” level.
Theoretical Functional Form Between Price and Ending Stocks
Corn Price and Ending Stocks/Use, 1975/76-2003/04: Reciprocal Model*

Source: USDA

*2003/04 Projected
Different Approaches to Account for Shifts in Relationship

• Include shifter variables directly in the pricing model and estimate one model for the entire sample period

• Estimate separate pricing models for sub-periods
  – The level of shifter variables is assumed to be relatively constant within a sub-period
Corn Price and Ending Stocks/Use, 1989/90-1997/98*

Source: USDA
Corn Price and Ending Stocks/Use, 1989/90-1997/98: Reciprocal Model*

Source: USDA

\[ y = 6.89 \left( \frac{1}{x} \right) + 1.90 \]

\[ R^2 = 0.96 \]
Corn Price and Ending Stocks/Use, 1989/90-2003/04: Reciprocal Model*

![Graph showing the relationship between corn price and ending stocks/use with a recursive model equation and R-squared value of 0.96.](image)

Source: USDA  
*2003/04 Projected
Corn Price and Ending Stocks/Use, 1989/90-2003/04: Reciprocal Models*

Source: USDA

*2003/04 Projected
What Changed During the Last Six Marketing Years?

• All else equal, supply shifted to the right
• Or, demand shifted to the left
  – FSI demand?
  – Export demand?
  – Feed demand?
  – Stock demand?
• Some combination of supply and demand shifts
US Planted and Harvested Corn Acreage, 1975/76-2003/04

Source: USDA
Difference Between US Planted and Harvested Corn Acreage, 1975/76-2003/04

Source: USDA

1990/91-2003/04 average w/out 1993/94 & 2002/03 = 7,006
Factors Affecting Acreage Decisions

• Economic theory suggests the following variables are important in farmer's acreage decisions,
  – Expected product price
  – Expected price for products that substitute in production
  – Input prices
  – Technological change
  – Risk
  – Government programs
  – Lagged effects
Ratio Indicators

- Given the complexities, analysts often combine variables into ratios that provide important “indicators” for supply decisions
- For crops, one of the most widely-followed is the ratio of soybean to corn prices
- Corn and soybeans “compete” for the same resources in production
- Opportunity cost concept
**Soybean-Corn Price Ratio**

- Indicator of incentives to switch acreage between soybeans and corn
- Key is the breakeven ratio (BEPR)
  - Ratio that equates the expected net returns from producing corn and soybeans
  - 2.5 typically is assumed BEPR
  - Assumes constant relative level of production costs and yields
Annual Average Soybean/Corn Price Ratio in the US, 1975/76-2003/04

Source: USDA

*2003/04 Projected
Change in Corn Acreage Share and Soybean/Corn Price Ratio, 1996/97-2003/04

\[ y = -5.2322x + 12.717 \]

\[ R^2 = 0.6849 \]
The Relative Level of Government Price Support

• 2000:
  – National average loan rate for soybeans $5.26/bu.
  – National average loan rate for corn $1.89/bu.
  – Ratio: 2.78, soybean production clearly encouraged relative to corn

• 2004:
  – National average loan rate for soybeans $5.00/bu.
  – National average loan rate for corn $1.95/bu.
  – Ratio: 2.56, soybean production slightly encouraged relative to corn
Limitations of Soybean-Corn Price Ratio

• Profitability of soybeans and corn can change due to:
  – Price of soybeans rising relative to corn, and vice versa
  – Input prices for soybeans rise relative to corn, and vice versa
  – Technology can improve for soybeans relative to corn, and vice versa
**USDA Acreage Surveys**

- Another alternative approach is to directly survey farmers about their planting intentions.
- USDA surveys farmers about acreage planting intentions in March and June.
- Since the USDA acreage surveys are so widely followed, it is important to examine the accuracy of these intentions.
March USDA Planting Intentions and Actual Planted Corn Acreage, 1975/76-2003/04

Source: USDA

*2003/04 Projected
June USDA Planting Intentions and Actual Planted Corn Acreage, 1975/76-2003/04

Source: USDA  
*2003/04 Projected
Error for March and June Planting Intentions for US Corn Acreage, 1975/76-2003/04

Source: USDA

*2003/04 Projected
Error for March Planting Intentions for US Corn Acreage, 1975/76-2003/04

Source: USDA

*2003/04 Projected
Conclusions

• Overall, evidence suggests that USDA acreage surveys provide good forecasts of actual planted acreage
• Typically, only small changes in corn and soybean planted acreage forecasts after the USDA releases the June acreage survey
Early Forecasts of Yield

• Consider this question: Previous to about June 1, what information do we have that is useful for predicting corn and soybean yields?

• During this period, we have little or no current information that is relevant to predicting yield.

• We will have to rely on past history of yields as our best data for forecasting at this point.

\[ y = 1.7294x + 88.417 \]

\[ R^2 = 0.6529 \]

Source: USDA

*2003/04 Projected
Early Season Production Forecasts

• Combine:
  – Planted acreage forecast
  – Harvested acreage forecast
  – Trend yield forecast
Improving on Trend Yield Forecasts

• More accurate yield forecasts can be generated as the following information becomes available,
  – Planting dates
  – Crop conditions
  – Rainfall
  – Temperature
  – Disease
  – Insect infestations
A Timeline for Corn Yield Forecasting

• Previous to June 1:
  – Trend yield forecasts
• June 1 to July 31:
  – USDA/NASS crop conditions ratings
  – Statistical models based on temperature, rainfall and other data
• August 1 to November 1:
  – USDA/NASS yield forecasts
  – USDA/NASS crop condition ratings
  – Statistical models based on temperature, rainfall and other data
USDA/NASS Forecasts of Corn Yields

- Corn yield forecasts made for the following dates:
  - August 1
  - September 1
  - October 1
  - November 1
  - January 1
Release Schedule

• Reports released to the public about the 10th of each month
• Note that planted acreage estimates are also updated for each report
• Usually, little change in acreage from June planting intentions report, so nearly all of the variation in crop size forecast is due to yields
Components of NASS Forecasts

- Reported NASS yield forecasts are based on two types of information
  - Farm operator survey
  - Objective yield survey
Farm Operator Survey

- Farmers’ assessment of yield prospects
- Samples drawn from a list frame consisting of the names, addresses, and telephone numbers of producers
- Same sample of farmers used for all forecast months
- Drawn from list frame developed for June Agricultural Survey
Objective Yield Survey

- Enumerators visit fields and record information about yield potential
- Sample fields are selected randomly from the area frame for the June Agricultural Survey
- Fields selected only for major producing states
- Same fields visited for each report
- Counts and measurements made in two plots in each field
Objective Yield Measurements

• Corn
  – Rowspace
  – 2 rows x 15 ft
  – Stalks
  – Ears & ear shoots
  – Ears with kernals
  – Kernal row length
  – Ear diameter
  – Ear weight

• Soybeans
  – Rowspace
  – 2 rows x 3.5 ft
  – Plants
  – Lateral branches
  – Blooms, dried flowers & pods
  – Pods with beans
  – Pod weight
Preparation of Crop Reports

- Agricultural Statistics Board reviews all indications and determines final national and regional yield estimates
- Farmer and objective yield indications are combined in a multistage process
  - Both statistical and judgmental techniques used
Errors for USDA August Corn Production Forecasts, 1970/71-2002/03

Source: USDA
Errors for USDA September Corn Production Forecasts, 1970/71-2002/03

Source: USDA
Errors for USDA October Corn Production Forecasts, 1970/71-2002/03

Source: USDA
Errors for USDA November Corn Production Forecasts, 1970/71-2002/03

Source: USDA
Conclusions

• Overall, evidence suggests that the USDA performs reasonably well in forecasting corn production
• Market participants view USDA corn production forecasts as important new information
• The following publication contains a complete analysis:
Forecasting Calendar for 2004/2005 Corn Use Categories

• Fall 2003: First forecasts of use for 2004/05 marketing year
  – Typically based on trend forecasts, recent history and basic economic relationships
• Spring and Summer 2004: Update use forecasts based on US and world production prospects
• 2004/05 Marketing Year: Update use forecasts based on export sales and inspections reports, quarterly USDA stocks reports and USDA livestock inventory reports
**Corn: Food, Seed, and Industrial Use**

- **Rapid growth in last 20 years**
  - About 10% of use in early 1980s
  - About 20% currently

- **Largest components are:**
  - Corn sweeteners for food and soft drinks
  - Corn starch for construction uses
  - Ethanol for fuel
  - Cereals, snack foods
  - Only ethanol use has been growing recently
Corn: Forecasting Food, Seed, and Industrial Use

• Food component tends to grow at the rate of population growth
• Relatively price insensitive
• Corn sweetener and ethanol use is critically affected by government policies
  – Sugar program
  – Ethanol subsidies
Food, Seed, and Industrial Use of Corn, 1975/76-2003/04 *

Source: USDA

*2003/04 Projected
Corn Exports, 1975/76-2003/04*

Source: USDA  
*2003/04 Projected
Corn: Forecasting Exports

- Large variation year-to-year and difficult to forecast
- Factors to consider
  - Crop production in importing and exporting countries
  - Prices in competing export countries
  - Exchange rates
  - Government export subsidy programs both in the US and other countries
  - Economic growth
  - Livestock numbers outside the US
Corn: Domestic Feed and Residual Use

- Largest component of corn use
- Averages about 60% of total corn consumption
- Primary driver of corn prices
- Largely dependent on the number of “grain consuming animal units”
Corn: Residual Use

• Wherever possible, use is cross-checked with objective information source
  – Export loadings at US ports
• Not all use can be cross-checked
• Leads to a category for “residual” or “unaccounted” use
  – Reflects measurement error in one or more use categories or in production estimates
  – Lumped together with feed usage in corn balance sheet
Corn: Forecasting Domestic Feed and Residual Use

- Related directly to the number of beef, pork and poultry animals on feed
- Number of animals on feed is, in turn, related to expected profits to livestock production
- Profitability depends on:
  - Livestock prices
  - Price of feed including corn
- Also have to account for relative price of feed inputs, such as sorghum and wheat
- Complex!
Domestic Feed and Residual Use of Corn, 1975/76-2003/04*

Source: USDA

*2003/04 Projected

\[ y = 75.143x + 3601.1 \]

\[ R^2 = 0.8173 \]
Changes in Demand

- Changes in quantity demanded and demand are NOT the same thing
- Change in quantity demanded
  - Movements along a demand curve
- Change in demand
  - Shifts in the demand curve
Demand and Use

- Demand and use are also not the same thing
- Use (usage, utilization, consumption)
  - Equilibrium quantity observed in a market
  - Equals both the quantity demanded and quantity supplied
# First Balance Sheet Estimates For 2004/05

<table>
<thead>
<tr>
<th>Item</th>
<th>USDA 2002-03</th>
<th>USDA 2003-04</th>
<th>Your Estimate 2004-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planted Acreage (1,000 acres)</td>
<td>79,054</td>
<td>79,066</td>
<td>79,250</td>
</tr>
<tr>
<td>Harvest Acreage (1,000 acres)</td>
<td>69,313</td>
<td>71,765</td>
<td>72,250</td>
</tr>
<tr>
<td>Yield (Bushels)</td>
<td>130</td>
<td>143</td>
<td>140.3</td>
</tr>
<tr>
<td>Beginning Stocks (million bushels)</td>
<td>1,596</td>
<td>1,086</td>
<td>1,349</td>
</tr>
<tr>
<td>Total Production (million bushels)</td>
<td>9,008</td>
<td>10,278</td>
<td>10,137</td>
</tr>
<tr>
<td><strong>Total Supply (million bushels)</strong></td>
<td><strong>10,619</strong></td>
<td><strong>11,374</strong></td>
<td><strong>11,496</strong></td>
</tr>
<tr>
<td>Feed and Residual (million bushels)</td>
<td>5,642</td>
<td>5,700</td>
<td>5,720</td>
</tr>
<tr>
<td>Food, Seed, and Industrial (million bushels)</td>
<td>2,298</td>
<td>2,450</td>
<td>2,520</td>
</tr>
<tr>
<td>Exports (million bushels)</td>
<td>1,592</td>
<td>1,875</td>
<td>1,875</td>
</tr>
<tr>
<td><strong>Total Consumption (million bushels)</strong></td>
<td><strong>9,533</strong></td>
<td><strong>10,025</strong></td>
<td><strong>10,115</strong></td>
</tr>
<tr>
<td>Ending Stocks (million bushels)</td>
<td>1,086</td>
<td>1,349</td>
<td>1,381</td>
</tr>
<tr>
<td>Ending Stocks/Total Consumption (%)</td>
<td>11.4</td>
<td>13.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Average Price ($/bu.)</td>
<td>2.32</td>
<td>2.10</td>
<td>2.12</td>
</tr>
</tbody>
</table>
Calculating the 2004/05 Price Forecast for Corn Using the Ending Stocks Model

\[ \frac{1}{\text{Ending Stocks/Total Use}} \times \text{Slope} + \text{Constant} = \text{US Average Farm Price} \]

\[ \frac{1}{\text{Ending Stocks/Total Use}} \times 12.18 + 1.22 = \text{US Average Farm Price} \]

\[ \frac{1}{13.6} \times 12.18 + 1.22 = \text{US Average Farm Price} \]

\[ 0.073 \times 12.18 + 1.22 = $2.12 \]
Forecasting the 2004/05 Corn Price Using the Ending Stocks Model

Source: USDA
Computing the 2004/05 Corn Price Implied from the Futures Market

<table>
<thead>
<tr>
<th>Calendar Month</th>
<th>Corn Futures Contract</th>
<th>11/21/03 Futures Price</th>
<th>Central Illinois 3-Yr. Avg. Basis</th>
<th>Central Illinois Cash Price Implied by Futures</th>
<th>Illinois 5-Yr. Avg. Marketing Weight</th>
<th>Price Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep-04</td>
<td>Dec-04</td>
<td>2.45</td>
<td>-0.21</td>
<td>2.23</td>
<td>6.8</td>
<td>0.15</td>
</tr>
<tr>
<td>Oct-04</td>
<td>Dec-04</td>
<td>2.45</td>
<td>-0.17</td>
<td>2.28</td>
<td>11.6</td>
<td>0.26</td>
</tr>
<tr>
<td>Nov-04</td>
<td>Dec-04</td>
<td>2.45</td>
<td>-0.13</td>
<td>2.32</td>
<td>6.0</td>
<td>0.14</td>
</tr>
<tr>
<td>Dec-04</td>
<td>Dec-04</td>
<td>2.45</td>
<td>-0.10</td>
<td>2.35</td>
<td>6.6</td>
<td>0.16</td>
</tr>
<tr>
<td>Jan-05</td>
<td>Mar-05</td>
<td>2.49</td>
<td>-0.15</td>
<td>2.34</td>
<td>20.4</td>
<td>0.48</td>
</tr>
<tr>
<td>Feb-05</td>
<td>Mar-05</td>
<td>2.49</td>
<td>-0.11</td>
<td>2.38</td>
<td>7.2</td>
<td>0.17</td>
</tr>
<tr>
<td>Mar-05</td>
<td>Mar-05</td>
<td>2.49</td>
<td>-0.09</td>
<td>2.40</td>
<td>8.4</td>
<td>0.20</td>
</tr>
<tr>
<td>Apr-05</td>
<td>May-05</td>
<td>2.52</td>
<td>-0.11</td>
<td>2.41</td>
<td>6.2</td>
<td>0.15</td>
</tr>
<tr>
<td>May-05</td>
<td>May-05</td>
<td>2.52</td>
<td>-0.10</td>
<td>2.42</td>
<td>5.6</td>
<td>0.14</td>
</tr>
<tr>
<td>Jun-05</td>
<td>Jul-05</td>
<td>2.55</td>
<td>-0.10</td>
<td>2.45</td>
<td>6.2</td>
<td>0.15</td>
</tr>
<tr>
<td>Jul-05</td>
<td>Jul-05</td>
<td>2.55</td>
<td>-0.11</td>
<td>2.44</td>
<td>7.6</td>
<td>0.19</td>
</tr>
<tr>
<td>Aug-05</td>
<td>Sep-05</td>
<td>2.55</td>
<td>-0.11</td>
<td>2.44</td>
<td>7.4</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Central Illinois Farm Price Forecast Implied from Futures $2.36
Central Illinois Basis Adjustment Relative to US Average $-0.05
US Average Farm Price Forecast Implied from Futures $2.31

US Average Farm Price from Ending Stocks Model $2.12