ACE 427
Spring 2009

Lecture 7

Forecasting Crop Prices Using Fundamental Analysis: Maximum Bid Price Models

by
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Required Reading:

Babcock B.A.. "How Low Can Corn Prices Go?." *Iowa Ag Review*, Fall 2008, Volume 14, No. 4, pp. 1-3, 11. (Class website)

Babcock B.A.. "Renewable Identification Numbers and the Renewable Fuels Standard: How They Support Corn and Soybean Prices." *Iowa Ag Review*, Winter 2009, Volume 15, No. 1, pp. 7-9. (Class website)

Introduction

The most basis question in _____ analysis is the _____ a prospective buyer (user) is willing to pay for a unit of the commodity

For at least the last 50 years the _____ determinant of the fundamental value of corn has been the value placed on corn by _____

"Master Model of Midwestern Agriculture," Hieronymus, Good and Hinton (1980) state:

The price of feed is determined by livestock feed demand, feed production, exports, and food and industrial uses. The lines of causation are from consumer demand through the livestock sector to feed prices. If a basic relationship between livestock and feed prices can be identified, we can then develop a concept of what feed is really worth. Then the price of feed at a given time can be judged as above or below its equilibrium value. We should not expect much stability in this relationship. The supply of feed available varies substantially from year to year because of production changes and variation in other demands, particularly for export. The livestock industry is not confronted with a stable feed supply but must continually adjust to variation.

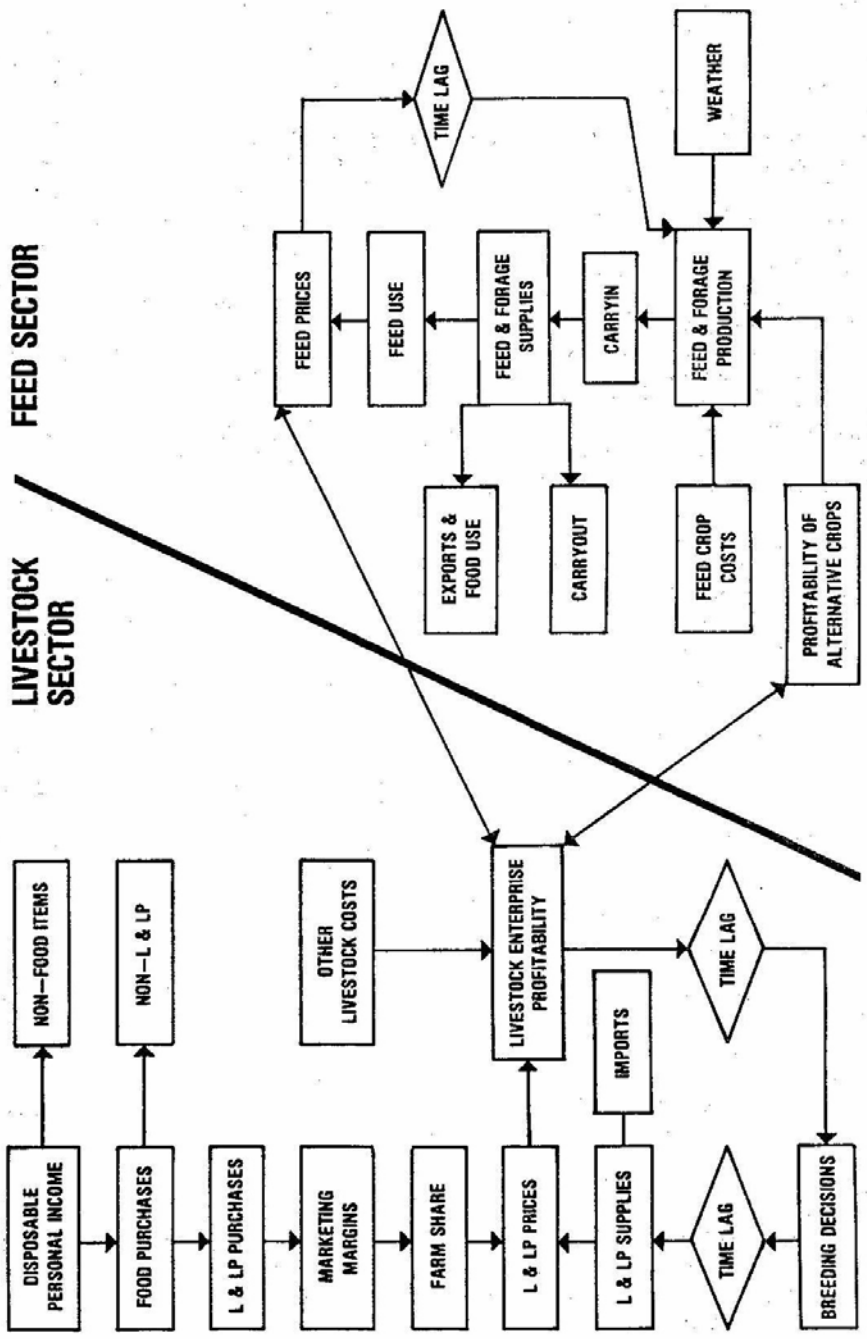
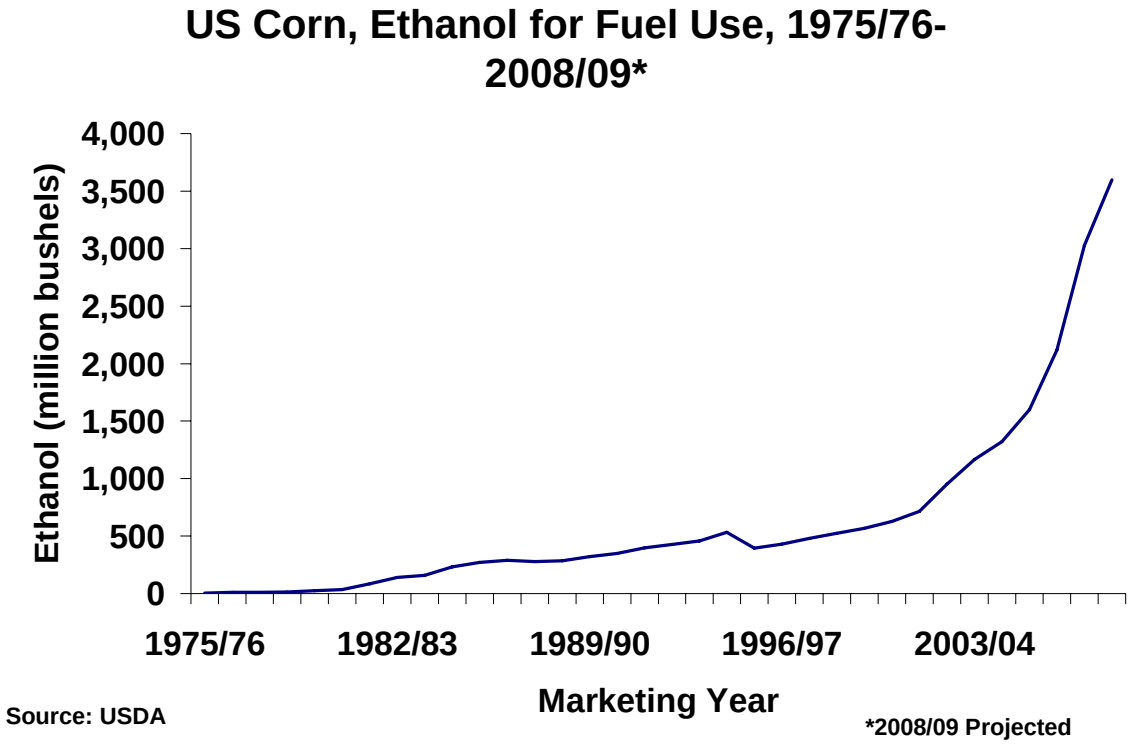
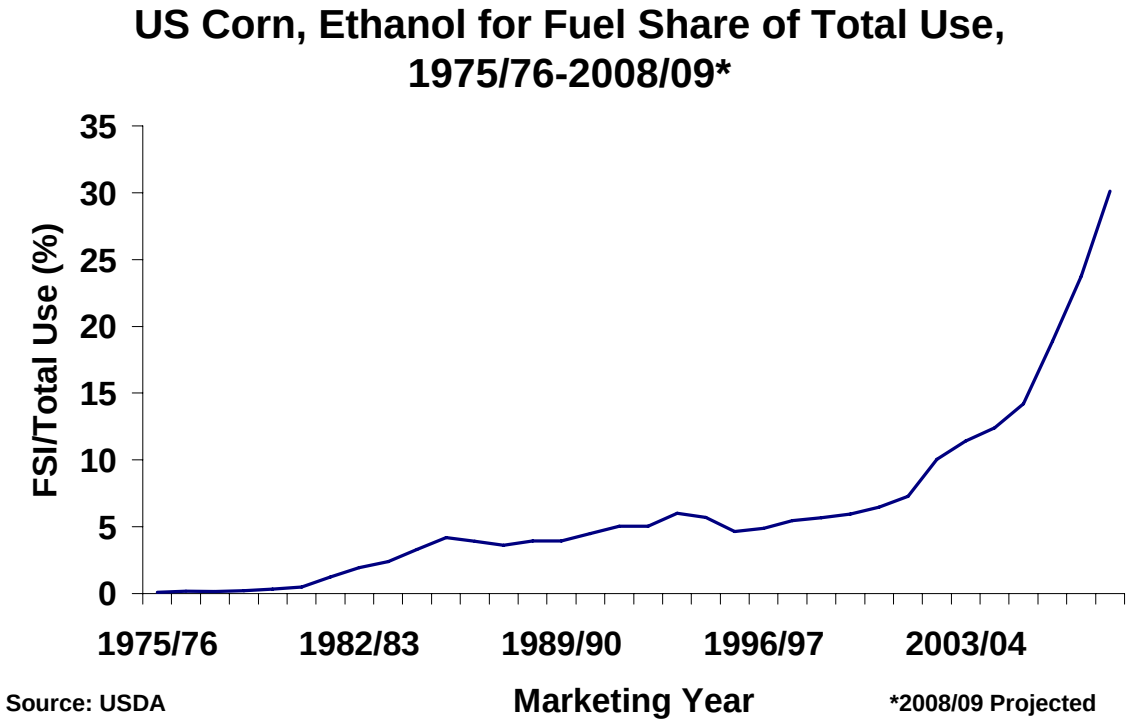


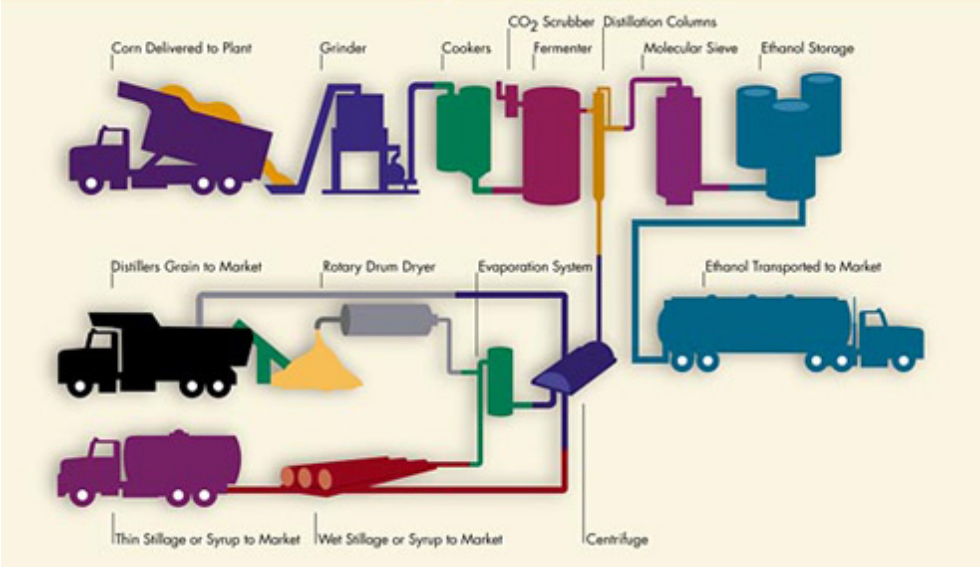
Figure 3–10. Master Model of Midwest Agriculture

The boom in _____ has caused a significant change in the basic economics of the crop sector





How is Ethanol Made? Dry Milling



In dry milling, the entire corn kernel or other starchy grain is first ground into flour, which is referred to in the industry as "meal" and processed without separating out the various component parts of the grain. The meal is slurried with water to form a "mash." Enzymes are added to the mash to convert the starch to dextrose, a simple sugar. Ammonia is added for pH control and as a nutrient to the yeast.

The mash is processed in a high-temperature cooker to reduce bacteria levels ahead of fermentation. The mash is cooled and transferred to fermenters where yeast is added and the conversion of sugar to ethanol and carbon dioxide (CO_2) begins.

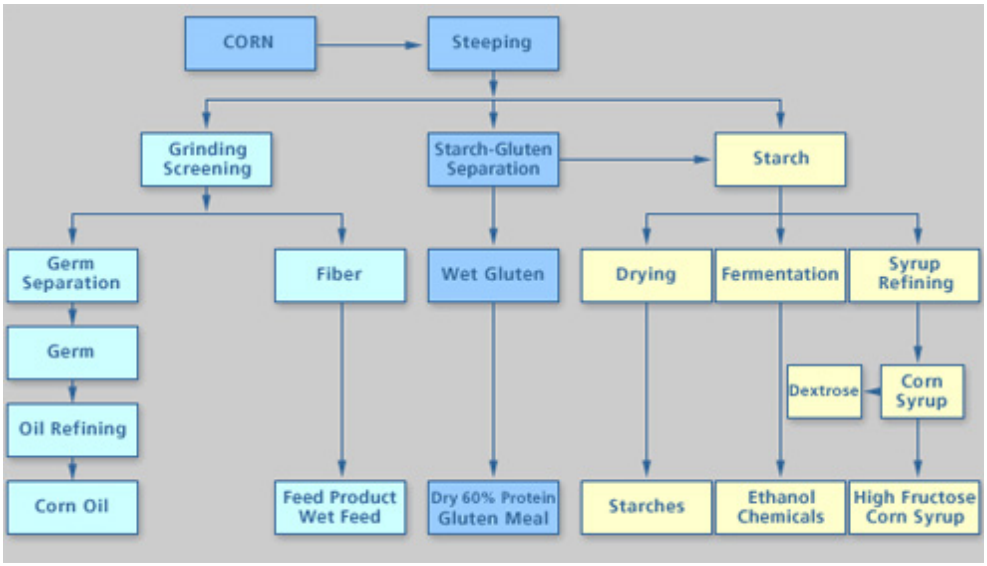
The fermentation process generally takes about 40 to 50 hours. During this part of the process, the mash is agitated and kept cool to facilitate the activity of the yeast. After fermentation, the resulting "beer" is transferred to distillation columns where the ethanol is separated from the remaining "stillage." The ethanol is concentrated to 190 proof using conventional distillation and then is dehydrated to approximately 200 proof in a molecular sieve system.

The anhydrous ethanol is then blended with about 5% denaturant (such as natural gasoline) to render it undrinkable and thus not subject to beverage alcohol tax. It is then ready for shipment to gasoline terminals or retailers.

The stillage is sent through a centrifuge that separates the coarse grain from the solubles. The solubles are then concentrated to about 30% solids by evaporation, resulting in Condensed Distillers Solubles (CDS) or "syrup." The coarse grain and the syrup are then dried together to produce dried distillers grains with solubles (DDGS), a high quality, nutritious livestock feed. The CO_2 released during fermentation is captured and sold for use in carbonating soft drinks and beverages and the manufacture of dry ice.

Source: Renewable Fuels Association (http://www.ethanolrfa.org/resource/made/)

How is Ethanol Made? Wet Milling



In wet milling, the grain is soaked or "steeped" in water and dilute sulfurous acid for 24 to 48 hours. This steeping facilitates the separation of the grain into its many component parts.

After steeping, the corn slurry is processed through a series of grinders to separate the corn germ. The corn oil from the germ is either extracted on-site or sold to crushers who extract the corn oil. The remaining fiber, gluten and starch components are further segregated using centrifugal, screen and hydroclonic separators.

The steeping liquor is concentrated in an evaporator. This concentrated product, heavy steep water, is co-dried with the fiber component and is then sold as corn gluten feed to the livestock industry. Heavy steep water is also sold by itself as a feed ingredient and is used as a component in Ice Ban, an environmentally friendly alternative to salt for removing ice from roads.

The gluten component (protein) is filtered and dried to produce the corn gluten meal co-product. This product is highly sought after as a feed ingredient in poultry broiler operations.

The starch and any remaining water from the mash can then be processed in one of three ways: fermented into ethanol, dried and sold as dried or modified corn starch, or processed into corn syrup. The fermentation process for ethanol is very similar to the dry mill process described above.

Source: Renewable Fuels Association (http://www.ethanolrfa.org/resource/made/)

Maximum Bid Price

Assume that the ethanol industry is the _____ bidder for corn

Maximum bid price model can be constructed based on a _____ constraint

- Long-run: determine the _____ that ethanol processors can pay after meeting fixed and variable costs of production plus a normal economic return

- Short-run: determine the _____ that ethanol processors can pay after meeting variable costs of production

- Assume that _____ will force ethanol processors to _____ the price of corn to the break-even level in the short- and long-run

Must have a good economic model of an _____ or _____ ethanol plant for this approach to be useful

Representative Ethanol Plant Model

A number of _____ models of ethanol plants have been constructed

We will construct one based on a recently published study at the University of Nebraska

- Surveyed 7 recently constructed ethanol plants for their production and cost information in 2006 and 2007
- One plant each in Nebraska, South Dakota, Minnesota, Iowa, Missouri, Wisconsin, and Michigan
- Provides _____ rather than _____ data on technical production coefficients and input costs

Key survey results:

- Average operating capacity: 53.1 million gallons of ethanol production annually

- Output efficiency for each bushel of corn processed:
  - _____ gallons of pure ethanol (E100)
  - _____ pounds distillers dried grain with solubles (DDGS) at 10% moisture
- Variable non-corn operating costs: _____ of corn processed
- We will use these results as the starting point for our representative ethanol plant model

The next step is to make some assumptions about _____ and _____ in order to compute _____

Lacking any better information, we are going to use the fixed costs from another model in use at Iowa State University:

- Assumes plant construction costs are _____ per gallon of ethanol production capacity
- 50% debt and 50% equity financing

- 8.5% interest on 10 year loan for debt financing

Fixed Costs

Depreciation	$0.3286/bu.
Interest	$0.2033/bu.
Labor & management	$0.0577/bu.
Property taxes	$0.0047/bu.
Total	$0.5943/bu.

To complete the model we need an estimate of the _____ required by the equity investors in the plant

This is the most _____ part of the model

We will follow other studies and simply assume that a _____ is required to compensate equity investors

- Assuming our plant is operating at capacity, it will use _____ million bushels of corn annually (53.1 million gallons of ethanol/2.86 gallons of ethanol per bushel of corn processed)

- The 50% equity investment of the plant owners is assumed to be _____ ($1.76/gallon of capacity x 53.1 million gallons x 50%)

- A 12% annual return on $46.7 million is $5.6 million per year

- We want to express this per bushel of corn processed, which is _____ ($5.6 million per year/18.6 million bushels)

Now we can summarize the cost estimates in our ethanol plant model

Total _____ costs per bushel of corn processed (18.6 million bushels annually):

Variable:	$1.30/bu.
Fixed:	$0.59/bu.
12% Return:	$0.30/bu.
Total:	_____

Computing the Maximum Bid Price

We are now ready to return to our original purpose, which is computing the _____ that an ethanol plant can _____ for the price of corn in the short- and long-run

To do this, we will combine information on the market price of _____ and _____ with our plant ____ estimates to imply maximum bid prices for corn

Basic idea: compute _____ from processing a bushel of corn and then subtract all _____ to infer a maximum bid price for corn

We will use data for March 6, 2009 as an example

Ethanol price at Iowa plants: $1.43/gal.
DDGS price at Iowa plants: $122.50/ton

Ethanol
$1.43/gal x 2.86 gal./bu. = _____

DDGS
$122.50/ton/2,000 x 16.56 lbs./bu. = _____

Gross Revenue: _____

Short-Run

Maximum bid price (breakeven) corn price in the short-run is simply _____ minus _____ _____

Remember the _____ rule from supply theory: a firm will continue operating in the short-run so long as they can at least cover all variable operating costs

Thus, for existing ethanol plants we estimate the maximum short-run bid price for corn on March 6, 2009 as

Gross revenue	_____
Variable costs	_____
Max SR bid	_____

Long-Run

Maximum bid price (breakeven) corn price in the long-run is simply gross revenue minus _____ _____

This will estimate the maximum price that an ethanol plant can pay for corn and _____ over the longer-term

Gross revenue _____
Variable costs _____
Fixed costs _____
12% return _____
Max LR bid _____

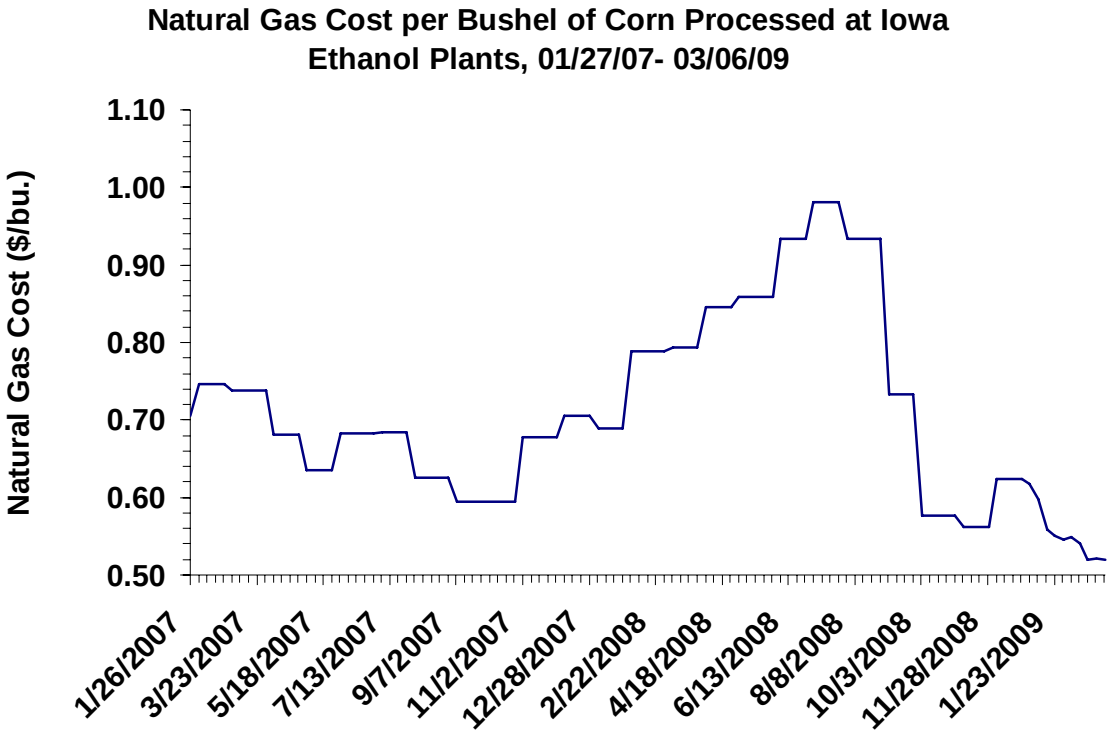
An alternative interpretation is that, given current ethanol and DDGS prices, the maximum price of corn to attract new _____ into the ethanol industry is _____

Maximum Bid Prices Over Time

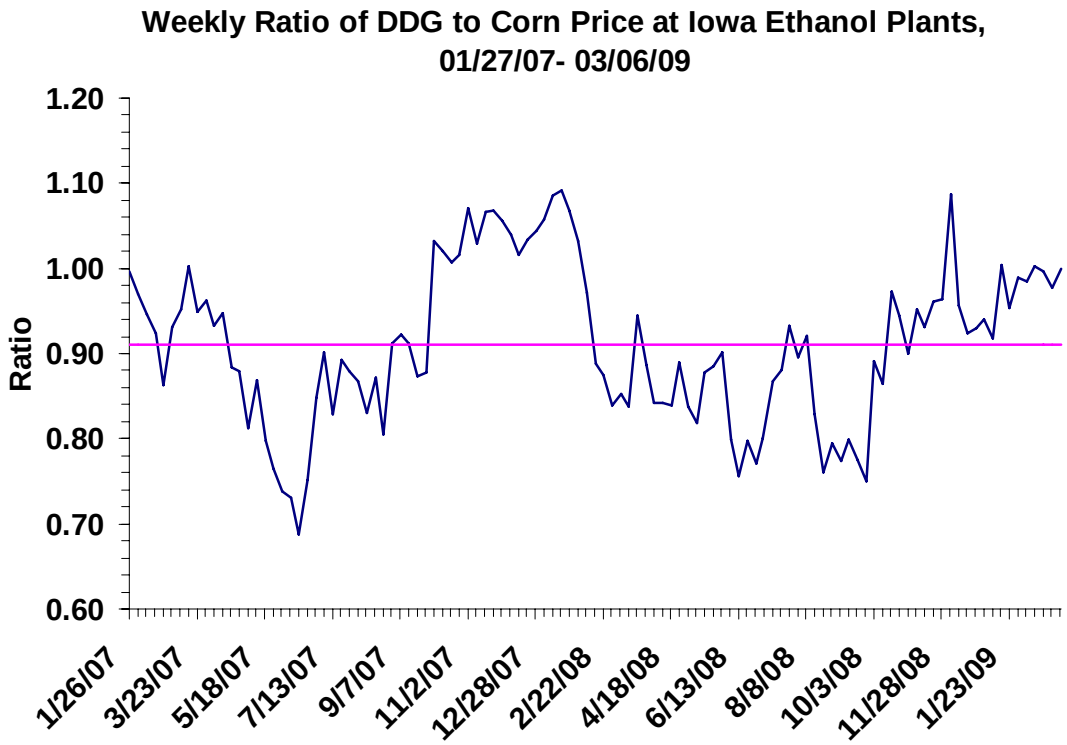
We can apply our economic model of a representative ethanol plant to time-series of ethanol and DDGS prices to determine how well actual corn prices _____ bid prices

A couple of tweaks to the model:

1. Allow non-corn variable costs to adjust to natural gas costs, the biggest component of variable operating costs



2. When computing maximum bid price we allow the price of DDGS to move with the bid price

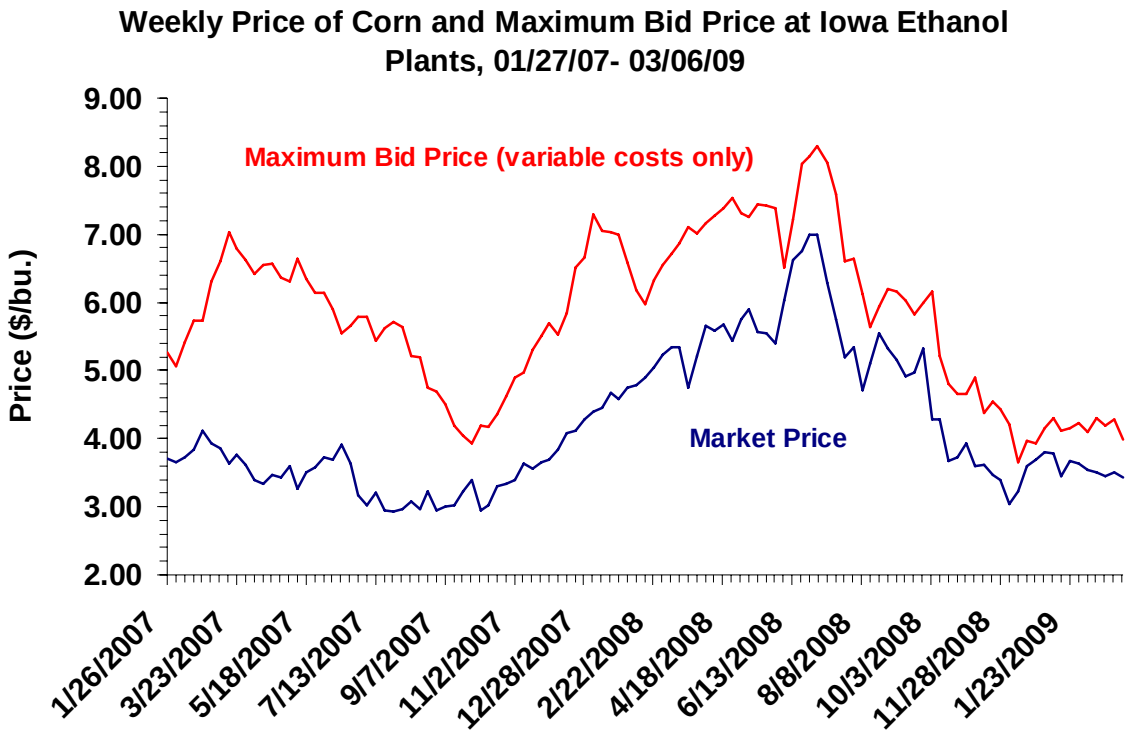


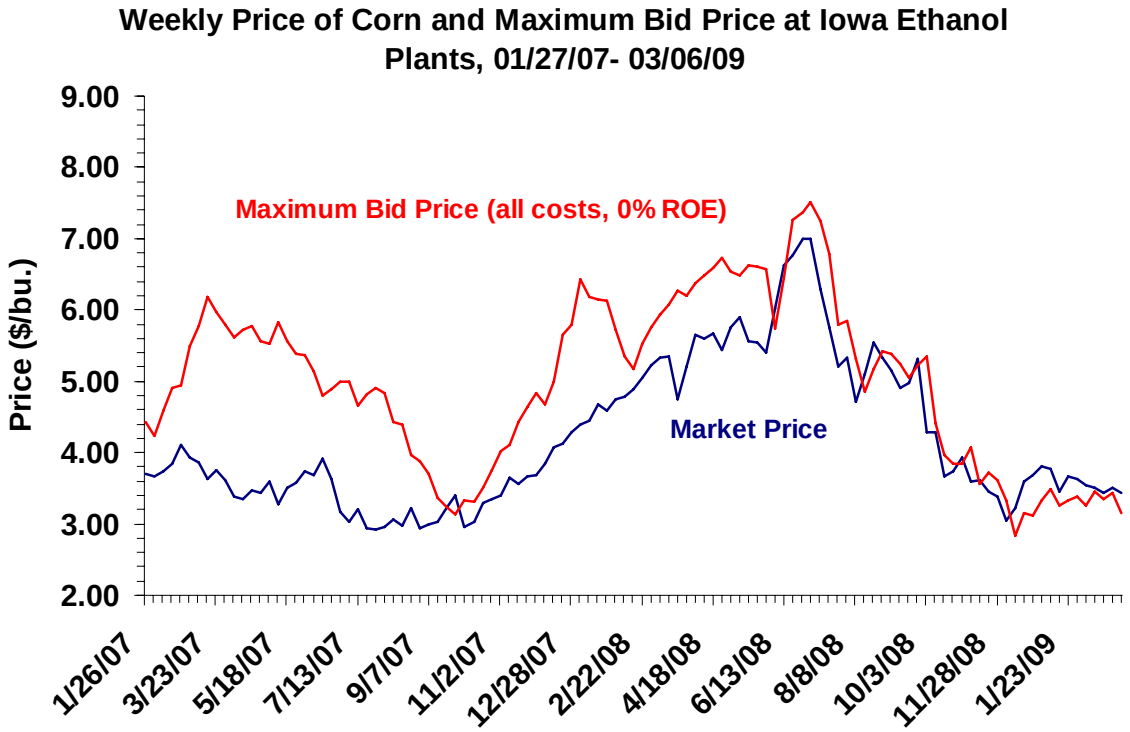
Notes on calculations:

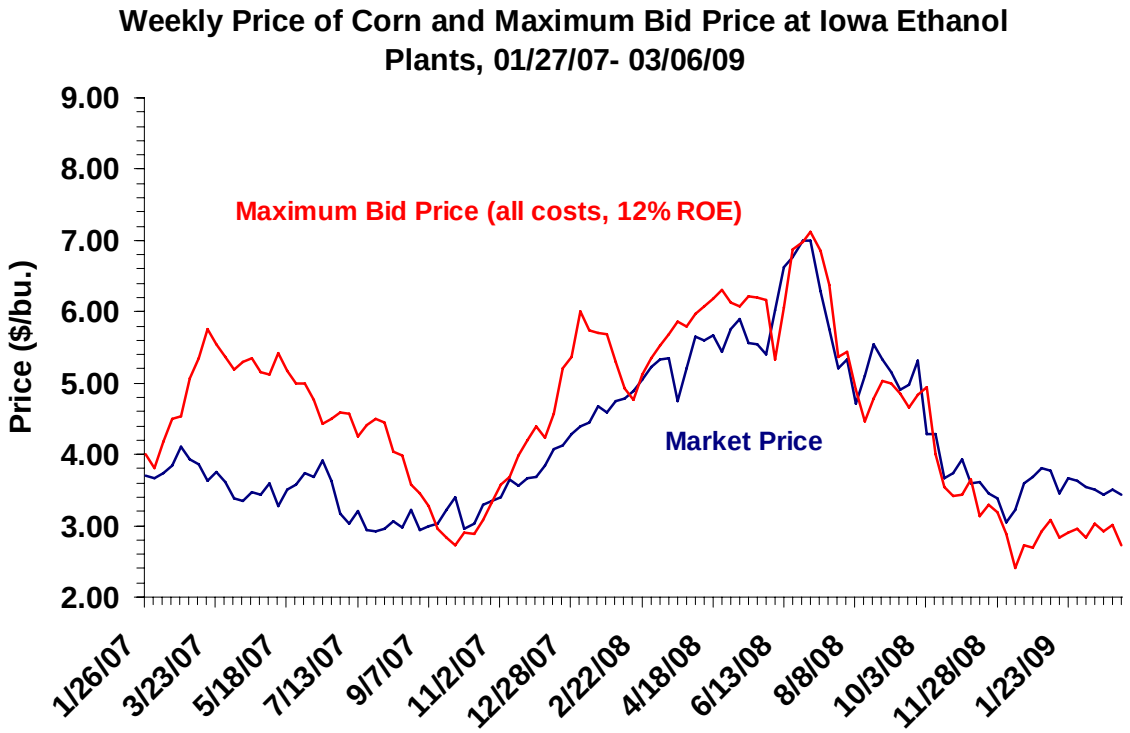
Use Iowa Ethanol Report data on ethanol and DDGS prices since this is the longest series of publically available data

Compute each week (Friday) maximum bid prices based on that week's ethanol and DDGS prices

Compare the bid prices to the price of corn at Iowa ethanol plants




Weekly Price of Corn and Maximum Bid Price at Iowa Ethanol Plants, 01/27/07- 03/06/09
Price ($/bu.)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
Maximum Bid Price (all costs, 0% ROE)
Market Price
1/26/07
3/23/07
5/18/07
7/13/07
9/7/07
11/2/07
12/28/07
2/22/08
4/18/08
6/13/08
8/8/08
10/3/08
11/28/08
1/23/09


Weekly Price of Corn and Maximum Bid Price at Iowa Ethanol Plants, 01/27/07- 03/06/09
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9.00
8.00
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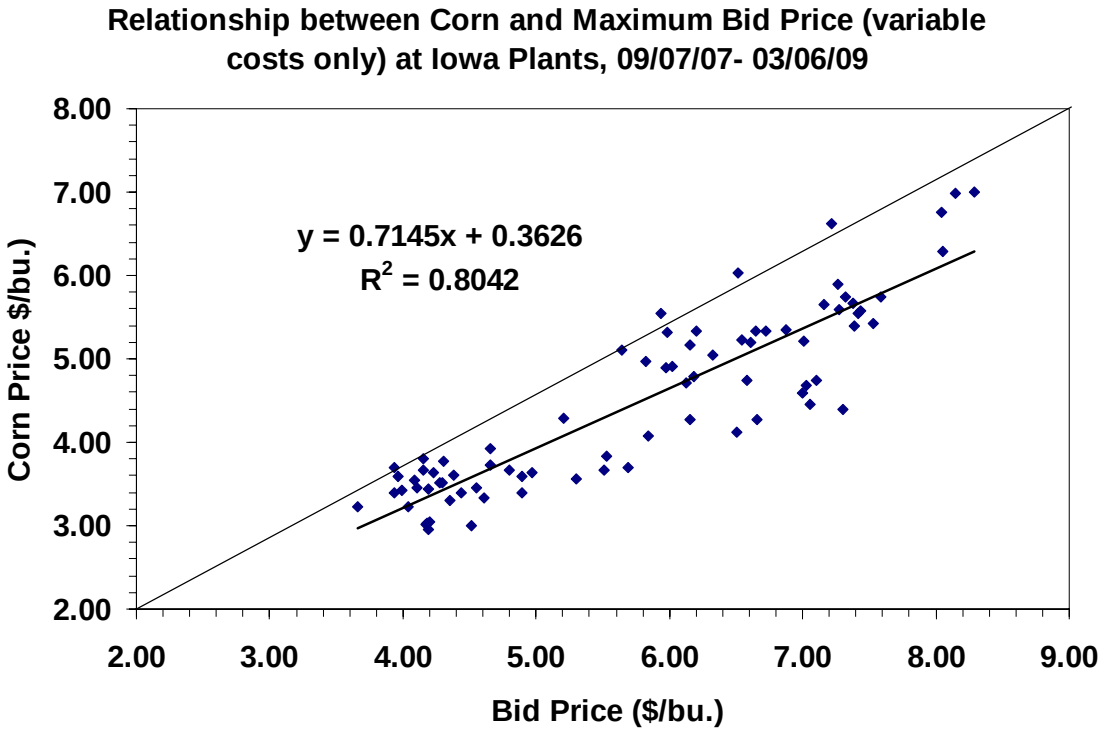
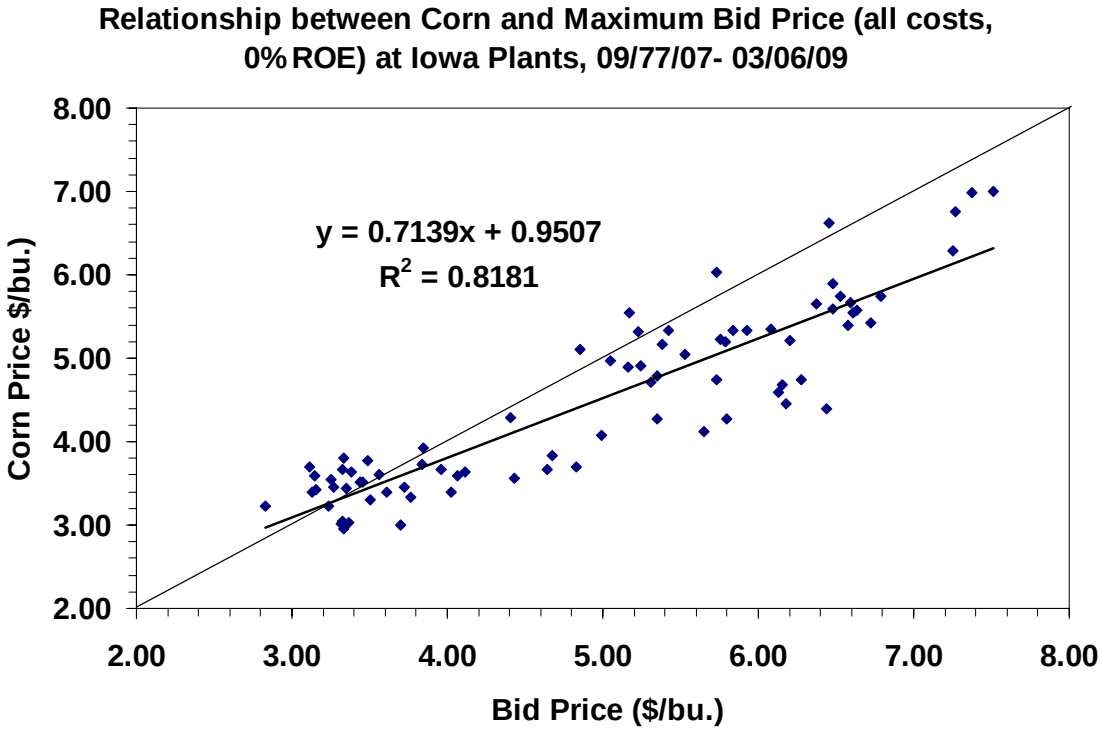
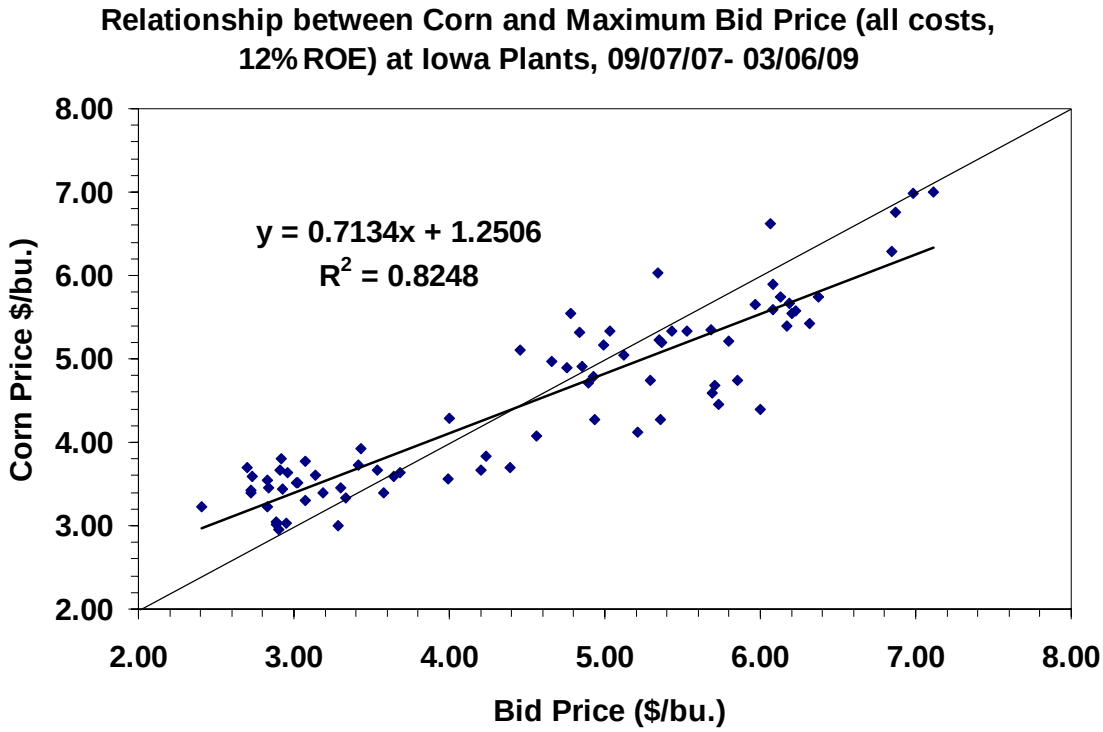
6.00
5.00
4.00
3.00
2.00
Maximum Bid Price (all costs, 12% ROE)
Market Price
1/26/07
3/23/07
5/18/07
7/13/07
9/7/07
11/2/07
12/28/07
2/22/08
4/18/08
6/13/08
8/8/08
10/3/08
11/28/08
1/23/09


Relationship between Corn and Maximum Bid Price (variable costs only) at Iowa Plants, 09/07/07- 03/06/09
y = 0.7145x + 0.3626
R2 = 0.8042
Corn Price $/bu.
Bid Price ($/bu.)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00


Relationship between Corn and Maximum Bid Price (all costs, 0% ROE) at Iowa Plants, 09/77/07- 03/06/09
y = 0.7139x + 0.9507
R2 = 0.8181
Corn Price $/bu.
Bid Price ($/bu.)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00



Conclusions

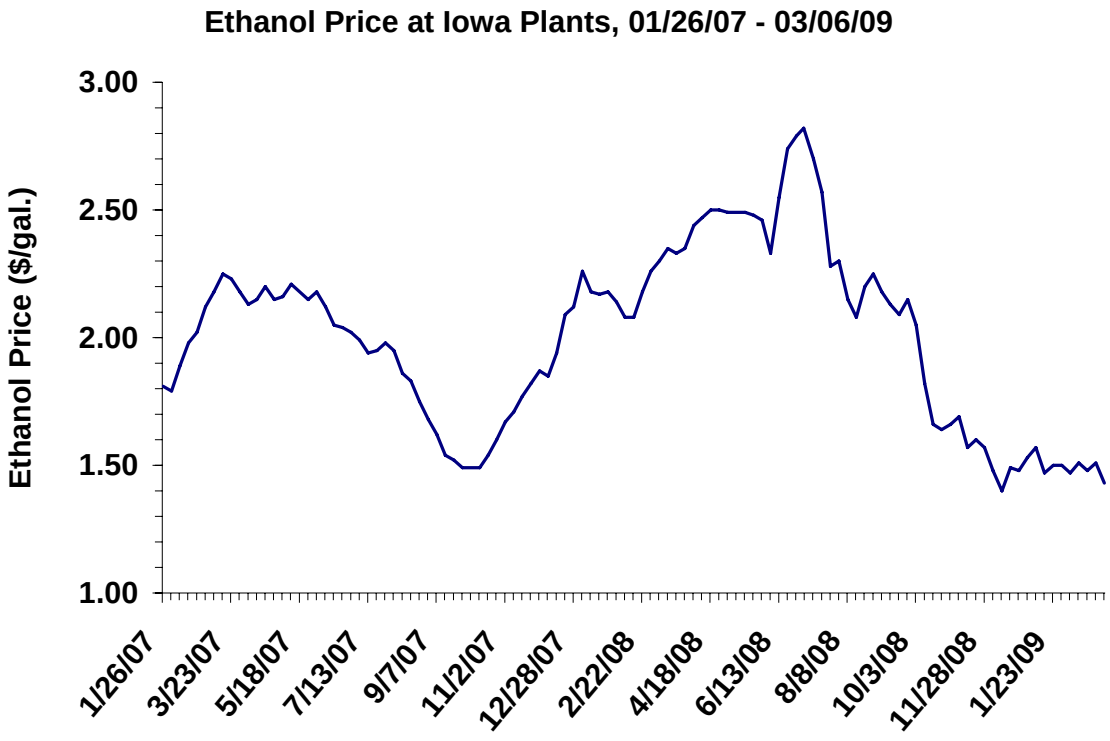
_____ of ethanol plants does _____ the price of corn since the beginning of the 2007/08 marketing year

Maximum bid prices assuming _____ including normal economic returns provide slightly higher explanatory power for corn prices

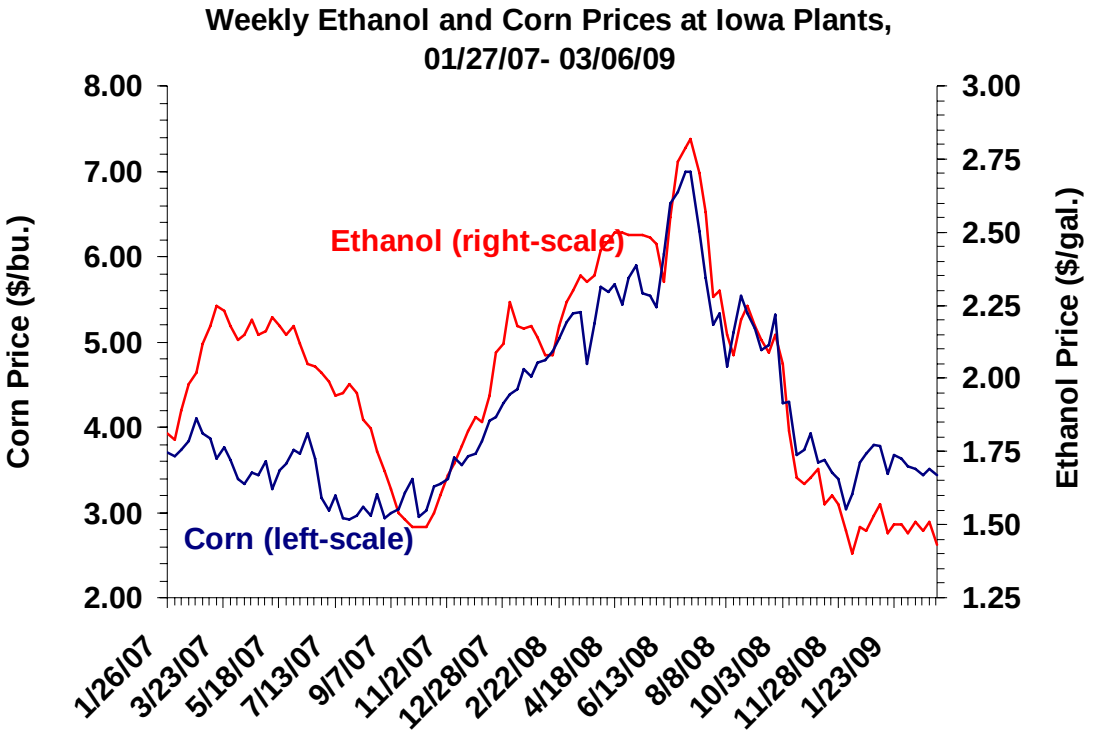
Relationship is far from _____!

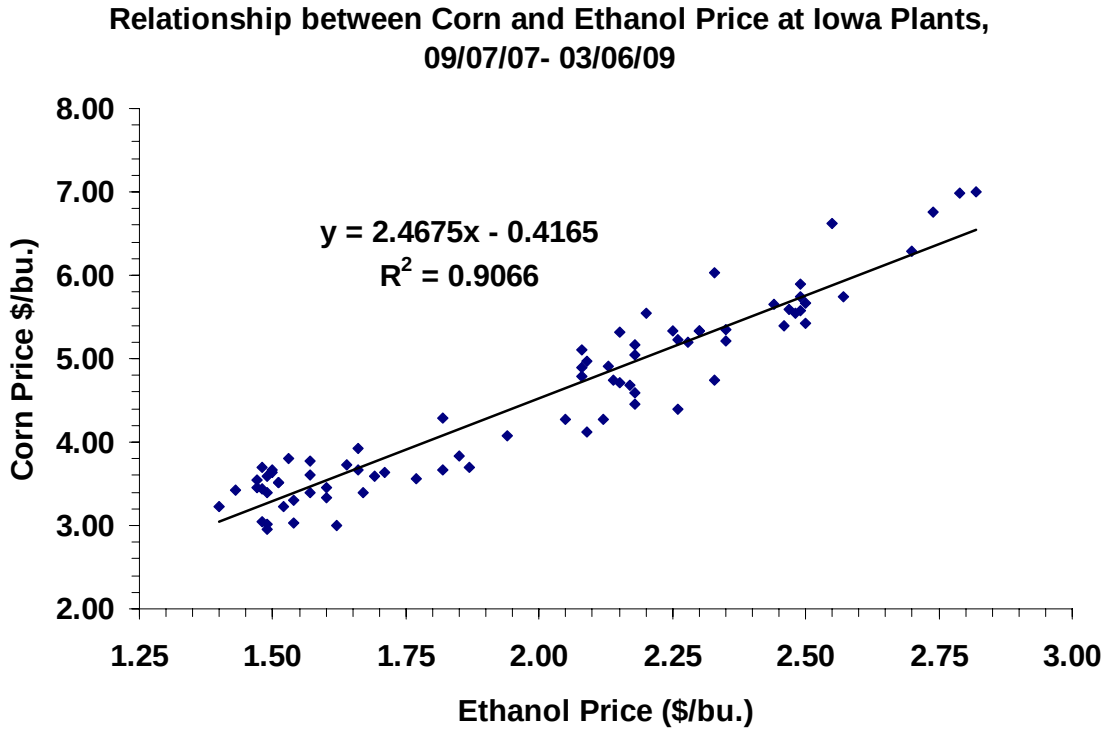
Ethanol Pricing Model

Assuming the cost estimates are representative, then the ____ variable in forecasting the _____ price of corn is the _____ price



The dependence of corn prices on ethanol prices can be illustrated directly


Weekly Ethanol and Corn Prices at Iowa Plants,
01/27/07- 03/06/09
Corn Price ($/bu.)
Ethanol Price ($/gal.)
Ethanol (right-scale)
Corn (left-scale)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1/26/07
3/23/07
5/18/07
7/13/07
9/7/07
11/2/07
12/28/07
2/22/08
4/18/08
6/13/08
8/8/08
10/3/08
11/28/08
1/23/09


Relationship between Corn and Ethanol Price at Iowa Plants,
09/07/07- 03/06/09
y = 2.4675x - 0.4165
R2 = 0.9066
Corn Price $/bu.
Ethanol Price ($/bu.)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00

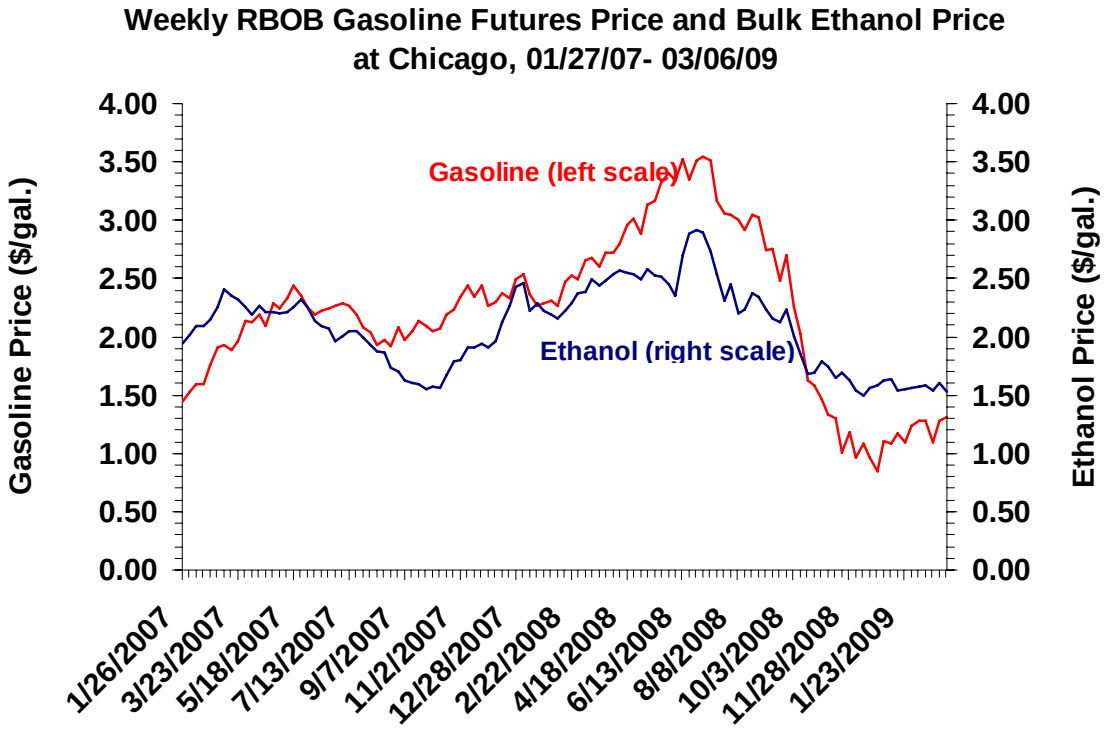
Implication: If we can forecast the price of ethanol then we can forecast the price of corn with reasonable accuracy

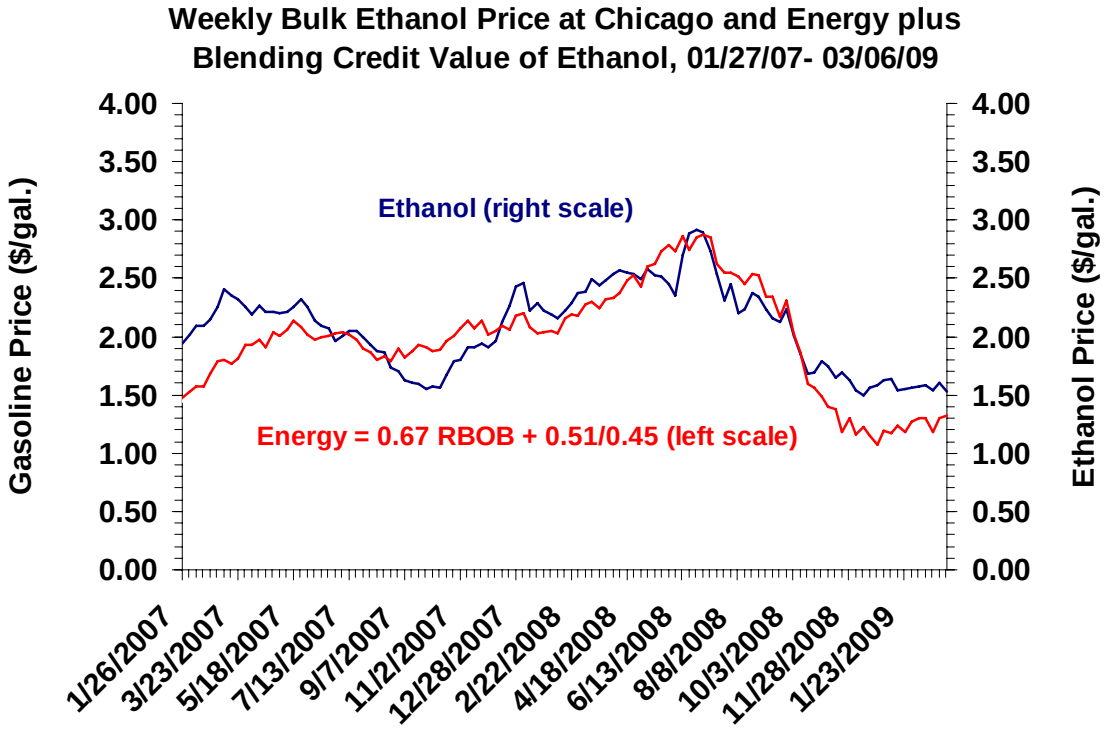
Main drivers of ethanol value:

- _____ (MTBE): price premium
- _____ direct competition with gasoline, ethanol contains 2/3 the BTUs of regular unleaded gasoline
- _____ $0.45 cent/gallon federal income tax credit to gasoline blenders for blending ethanol with unleaded gasoline
- _____ set minimum national standards for blending of ethanol with unleaded gasoline

The simplest pricing model for ethanol is called the _____

EV = 0.667 x gasoline $/gal. + $0.45/gal. tax credit

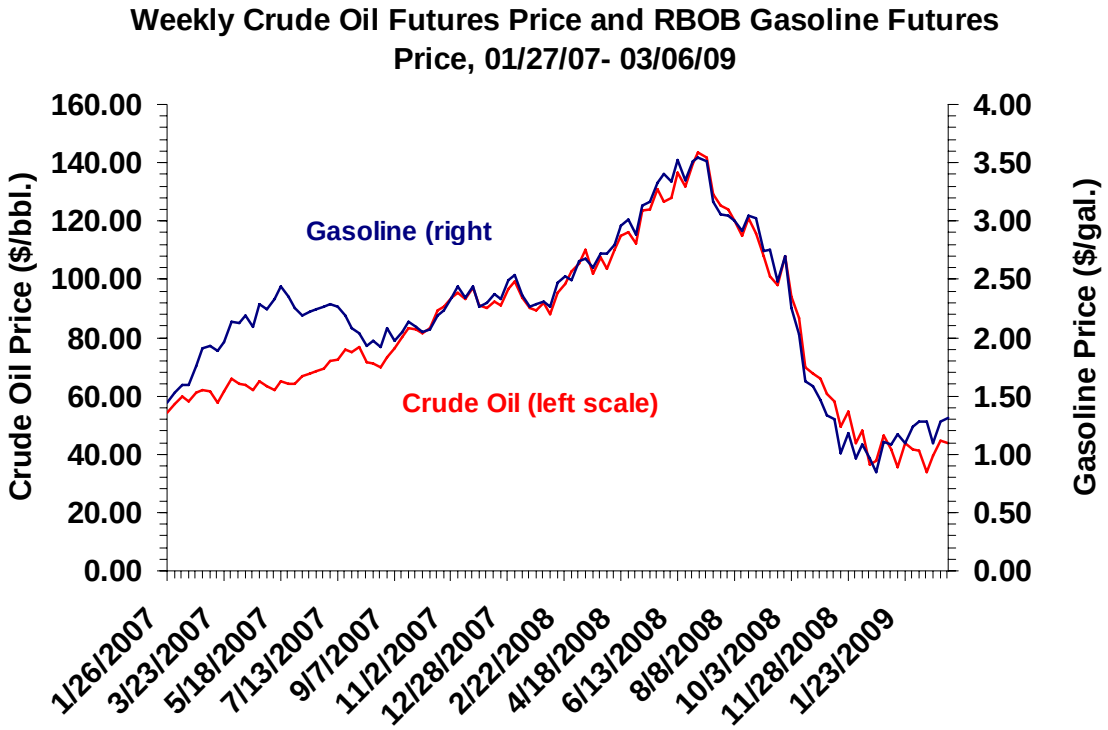

Weekly RBOB Gasoline Futures Price and Bulk Ethanol Price at Chicago, 01/27/07- 03/06/09
Gasoline Price ($/gal.)
Ethanol Price ($/gal.)
Gasoline (left scale)
Ethanol (right scale)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1/26/2007
3/23/2007
5/18/2007
7/13/2007
9/7/2007
11/2/2007
12/28/2007
2/22/2008
4/18/2008
6/13/2008
8/8/2008
10/3/2008
11/28/2008
1/23/2009

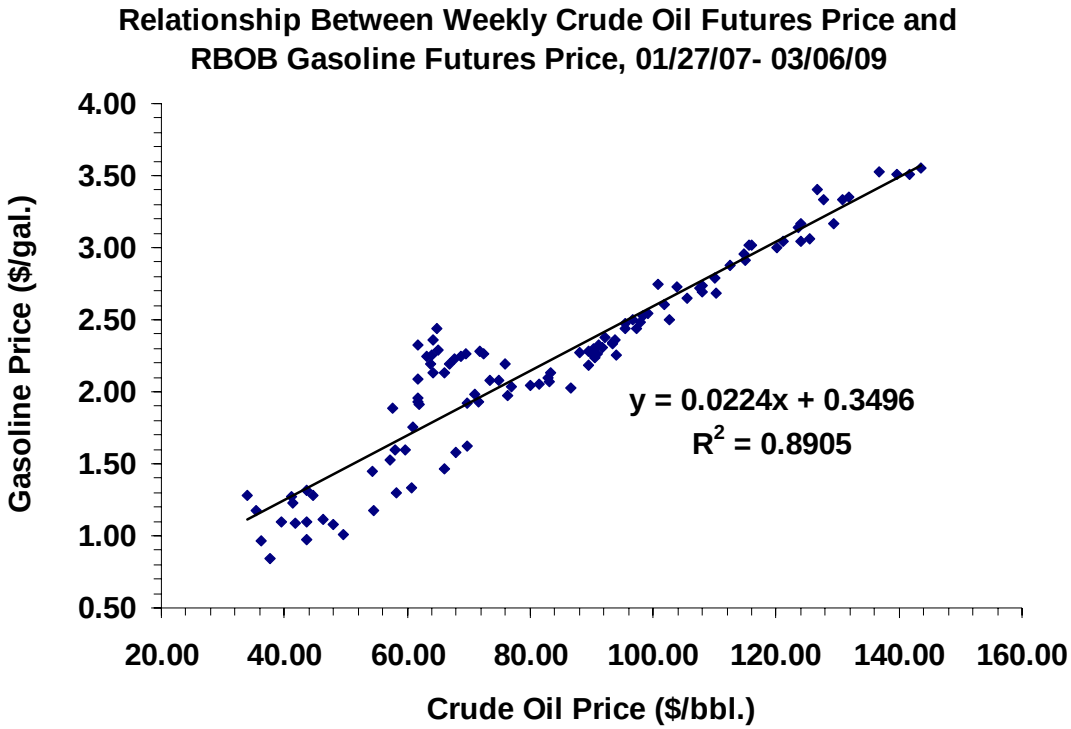

Weekly Bulk Ethanol Price at Chicago and Energy plus Blending Credit Value of Ethanol, 01/27/07- 03/06/09
Gasoline Price ($/gal.)
Ethanol Price ($/gal.)
Ethanol (right scale)
Energy = 0.67 RBOB + 0.51/0.45 (left scale)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1/26/2007
3/23/2007
5/18/2007
7/13/2007
9/7/2007
11/2/2007
12/28/2007
2/22/2008
4/18/2008
6/13/2008
8/8/2008
10/3/2008
11/28/2008
1/23/2009

If ethanol is priced solely for its energy + blending credit value, then the price of ethanol is _____ _____ on the price of wholesale unleaded _____

Of course, this means we have to forecast the price of gasoline in order to forecast the price of ethanol in order to forecast the price of corn!

There is a _____ relationship between wholesale unleaded gasoline prices and crude oil prices





Now, we have to forecast the price of crude oil in order to forecast the price of gasoline in order to forecast the price of ethanol in order to forecast the price of corn!!

The net result is a linked chain between crude oil and corn prices:

Price of crude oil

Price of unleaded gasoline

Price of ethanol

Price of corn

So, we can gather the _____ equations for each link in the chain as follows:

Gasoline Price = 0.3496 + 0.0224 x Crude Oil Price

Ethanol Price = 0.667 x Gasoline Price + 0.45

Corn Price = - 0.4165 + 2.4675 x Ethanol Price

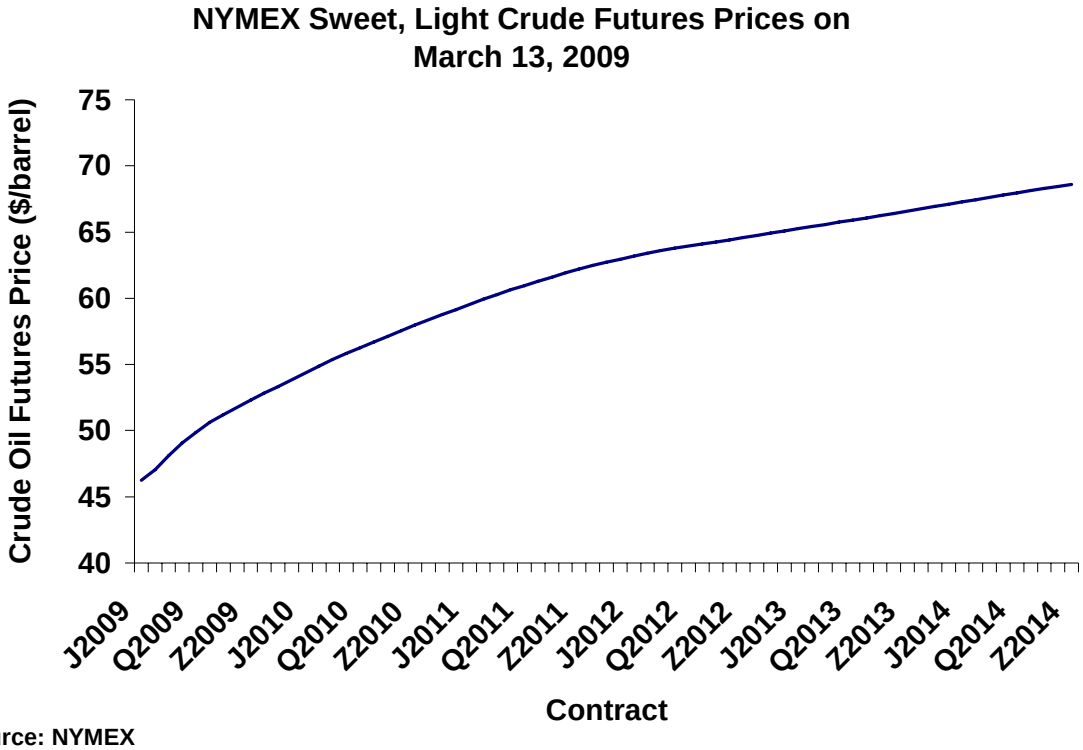
and via substitution

Corn Price = 1.2693 + 0.0369 x Crude Oil Price

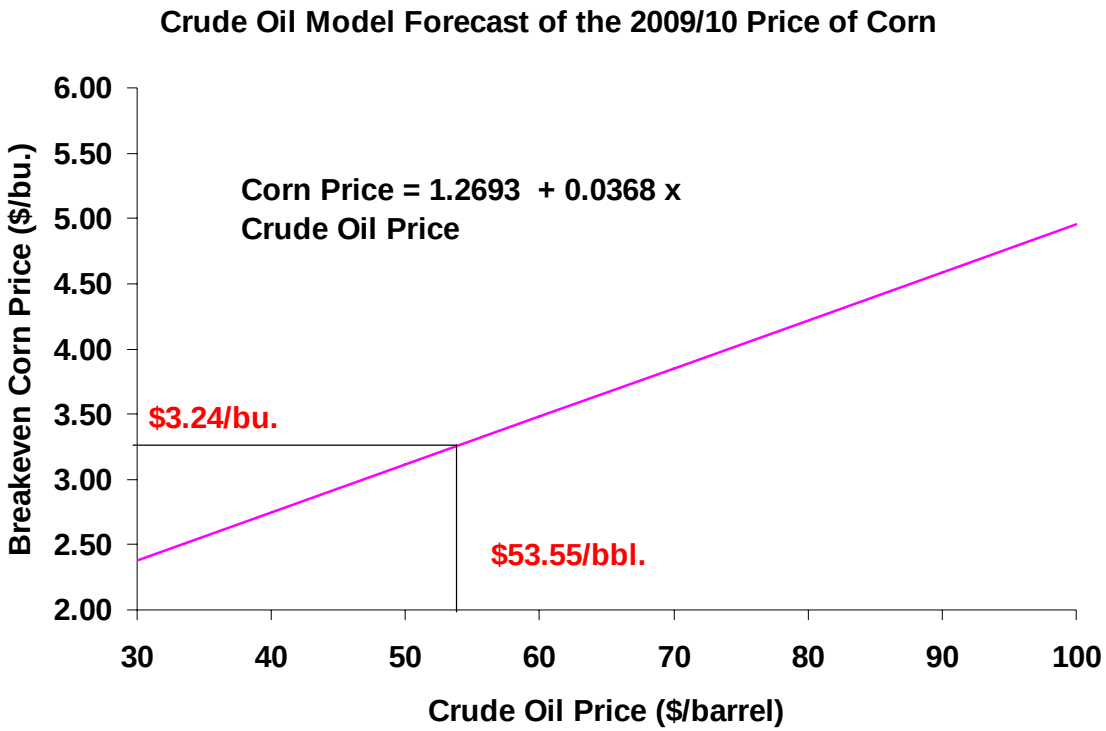
	Wholesale		
Crude	Gasoline	Ethanol	Corn
Oil	Price	Price	Price
$/bbl.	$/gal.	$/gal.	$/bu.
100	2.59	2.18	4.96
90	2.37	2.03	4.59
80	2.14	1.88	4.22
70	1.92	1.73	3.85
60	1.69	1.58	3.48
50	1.47	1.43	3.11
40	1.25	1.28	2.74
30	1.02	1.13	2.38
20	0.80	0.98	2.01

The energy model highlights the _____ role that _____prices now play in corn market fundamentals

- At least in theory, if you can forecast the price of crude oil, you can forecast the price of corn
- As we studied in the last lecture, the _____ _____ is one widely-used source of forecasts



Source: NYMEX


Crude Oil Model Forecast of the 2009/10 Price of Corn
Corn Price = 1.2693 + 0.0368 x Crude Oil Price
$3.24/bu.
$53.55/bbl.
Breakeven Corn Price ($/bu.)
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
30
40
50
60
70
80
90
100
Crude Oil Price ($/barrel)

Comparison of Average Relationships to Current Prices

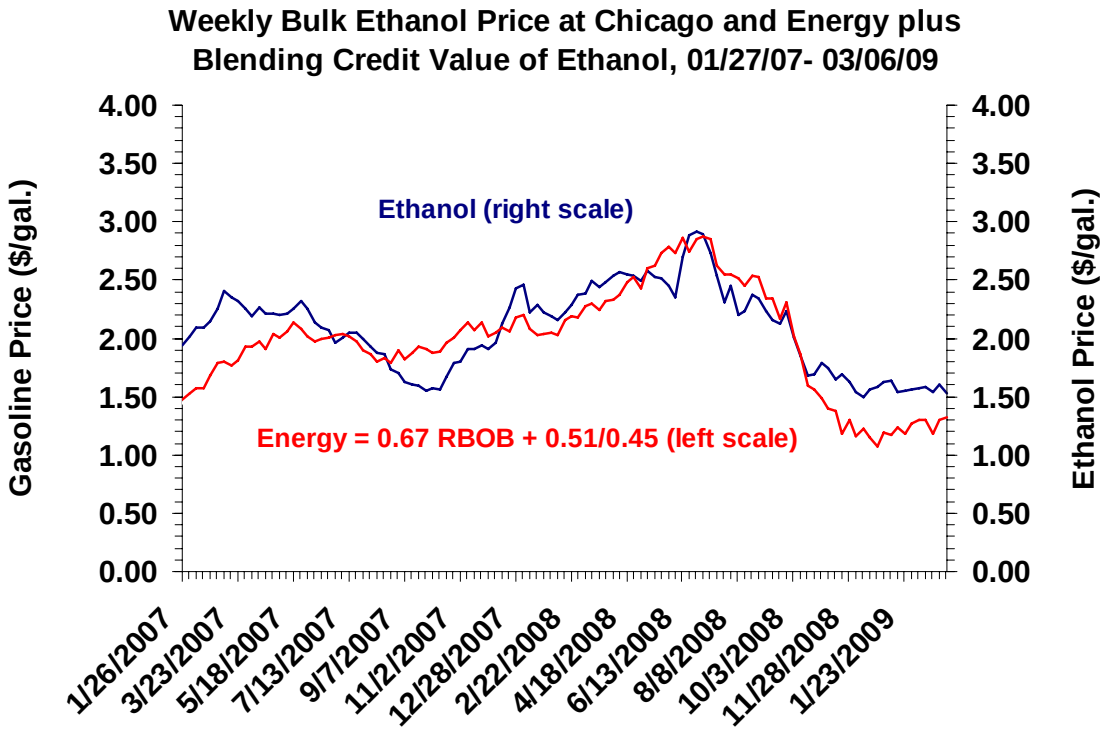
	Wholesale		
Crude	Gasoline	Ethanol	Corn
Oil	Price	Price	Price
$/bbl.	$/gal.	$/gal.	$/bu.
100	2.59	2.18	4.96
90	2.37	2.03	4.59
80	2.14	1.88	4.22
70	1.92	1.73	3.85
60	1.69	1.58	3.48
50	1.47	1.43	3.11
40	1.25	1.28	2.74
30	1.02	1.13	2.38
20	0.80	0.98	2.01

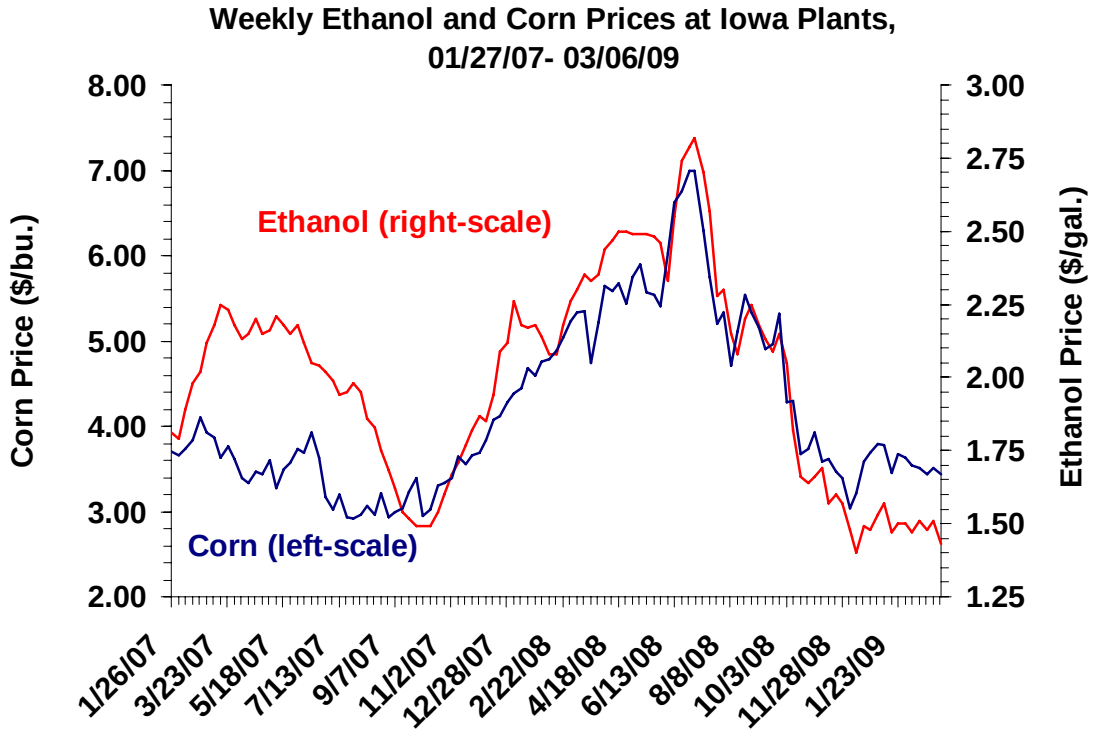
Gasoline Price = 0.3496 + 0.0224 x Crude Oil Price

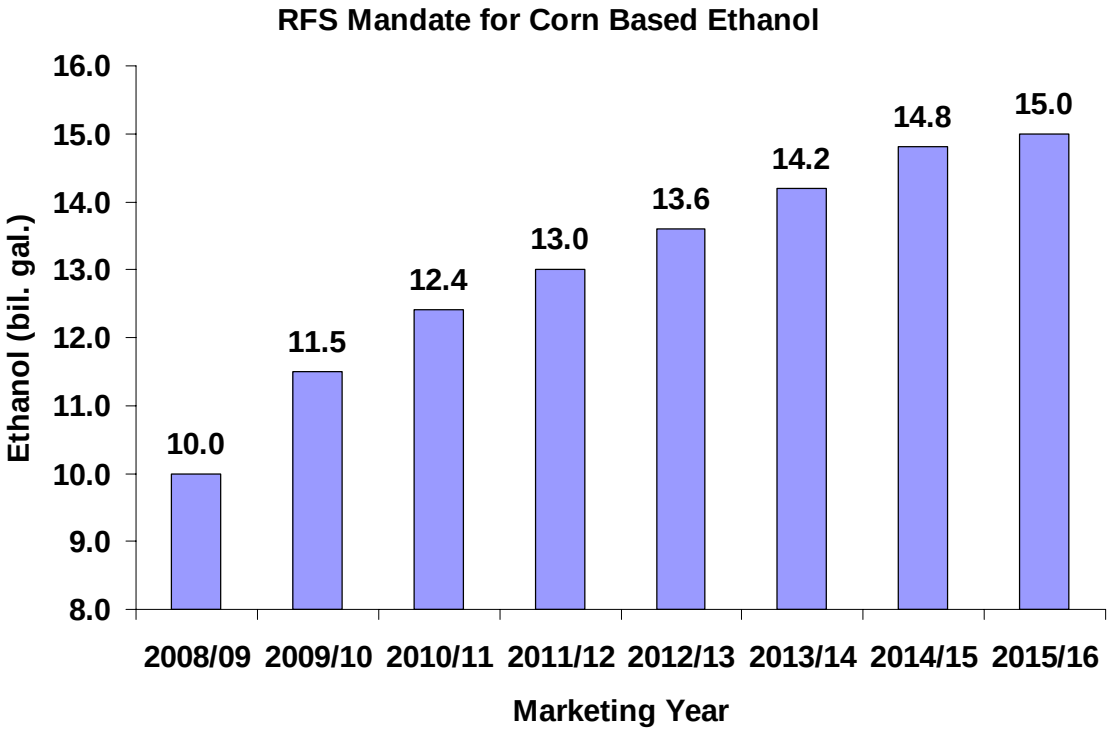
Ethanol Price = 0.667 x Gasoline Price + 0.45

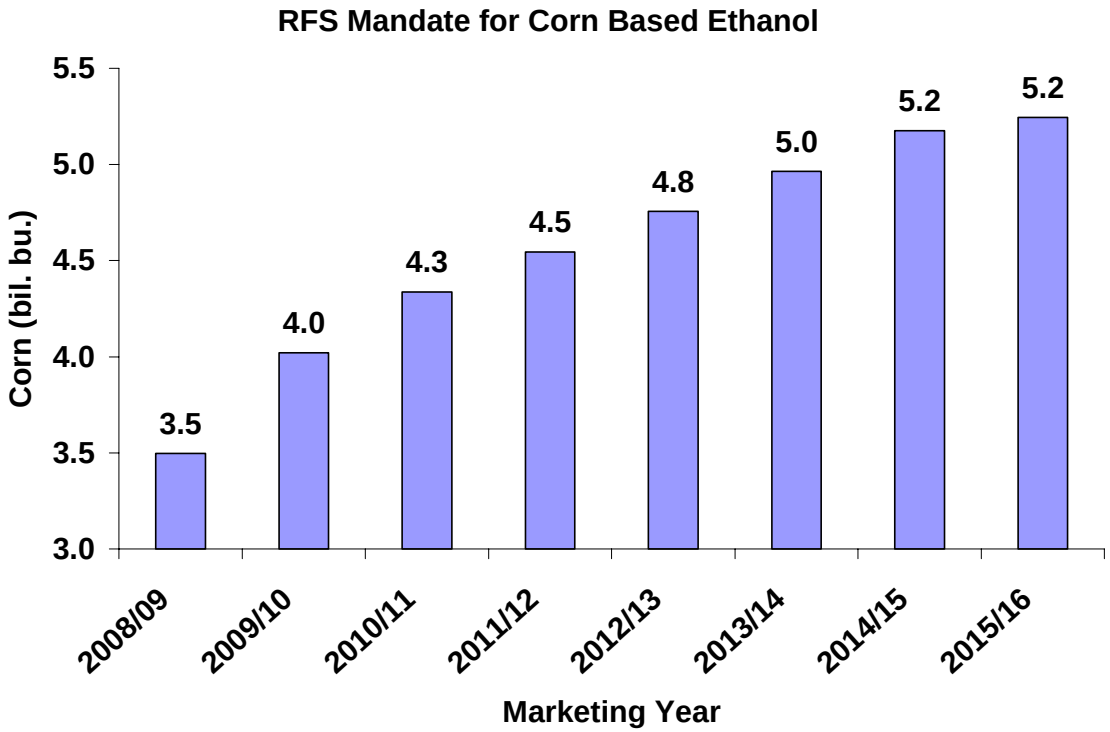
Corn Price = -0.4165 + 2.4675 x Ethanol Price

Perplexing Facts

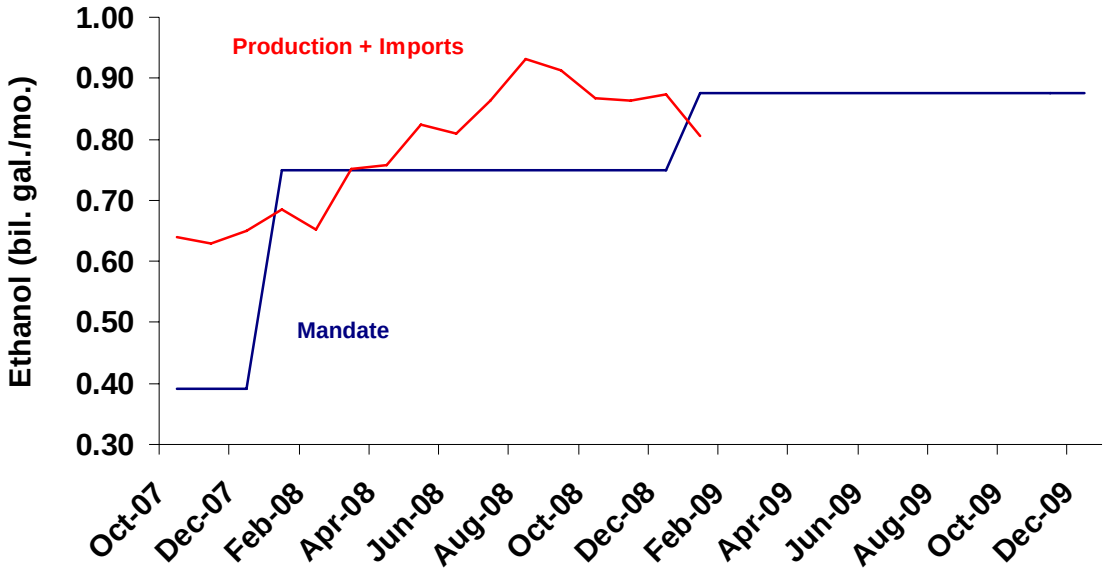





RFS Mandate for Corn Based Ethanol
Ethanol (bil. gal.)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
10.0
11.5
12.4
13.0
13.6
14.2
14.8
15.0
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Marketing Year


RFS Mandate for Corn Based Ethanol
Corn (bil. bu.)
5.5
5.0
4.5
4.0
3.5
3.0
3.5
4.0
4.3
4.5
4.8
5.0
5.2
5.2
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Marketing Year

Monthly U.S. Ethanol Production + Imports vs. RFS Mandate, October 2007 - December 2009*



Source: EIA/EPA

* Jan 09 Production + Imports Projected

Key Questions

1. Why was ethanol production generally _____ the mandated level until recently?

   - In 2006 and into 2007 ethanol was at a _____ to its energy + blending credit value due to the banning of MTBE and its replacement by ethanol as a gasoline _____

- After this period, ethanol tended to be priced in the market close to its energy + blending credit value (until late October 2008)

- While corn prices began to _____ energy values during this time period, corn prices were still at levels that allowed ethanol production to remain _____

2. Why is ethanol production now falling _____ mandated levels?

- Many ethanol companies followed highly _____ marketing strategies that led to large financial losses and ultimately bankruptcy

- Corn prices did not fully track the decline in ethanol prices from peaks last summer to recent lows, which resulted in _____ margins and plant shutdowns in some cases

- This could be a short-run supply/demand issue or it could indicate that ethanol processors have been _____ as the marginal bidder for corn, at least temporarily

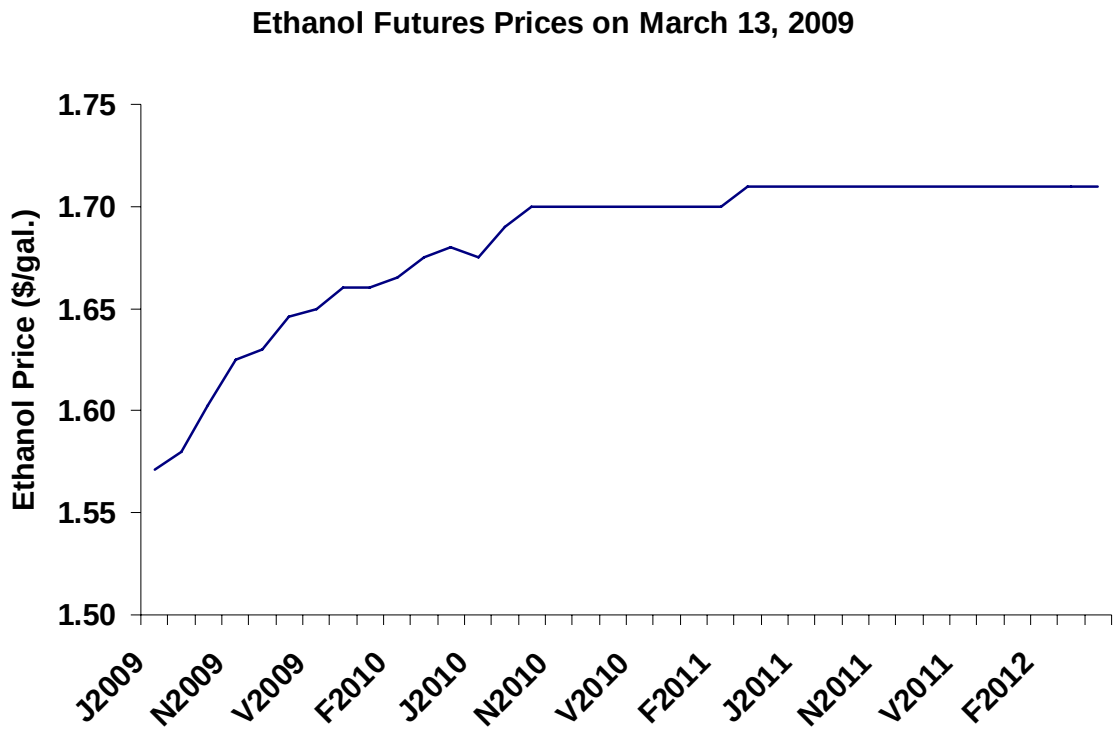
3. Can ethanol production for 2009 actually end up _____ the mandated level? The answer is ___ for several reasons

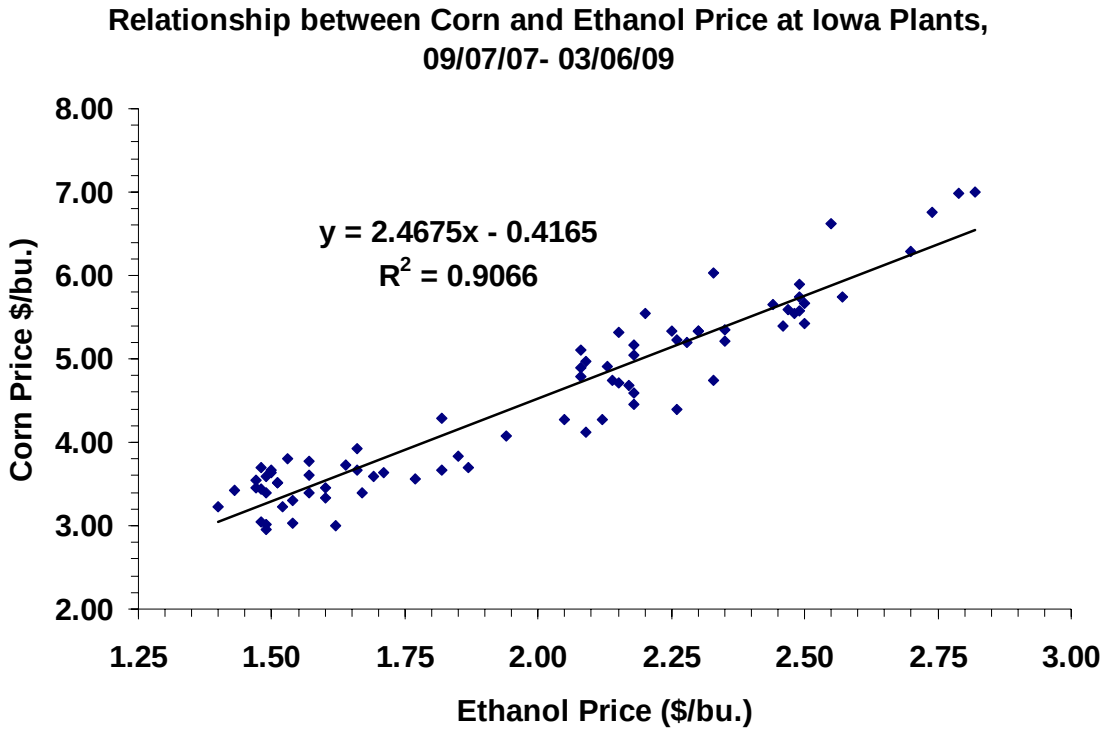
- Ethanol production could _____ later in the year to make up the current deficit
- Gasoline blending companies can run _____ compared to their mandated use of ethanol in a given year (but they have to make up any deficit in the following year)
- Gasoline blending companies can _____ credit (RINS) from previous years when they produced in _____ of the mandated level
- Gasoline blending companies can _____ credits (RINS) from another blending company with an excess of ethanol produced either in earlier years or the current years

Implications

Assuming the RFS mandate is in fact _____ the crude oil pricing model _____ the price of corn because: i) ethanol is priced above its historical relationship to crude oil and gasoline and ii) corn is priced above its historical relationship to ethanol

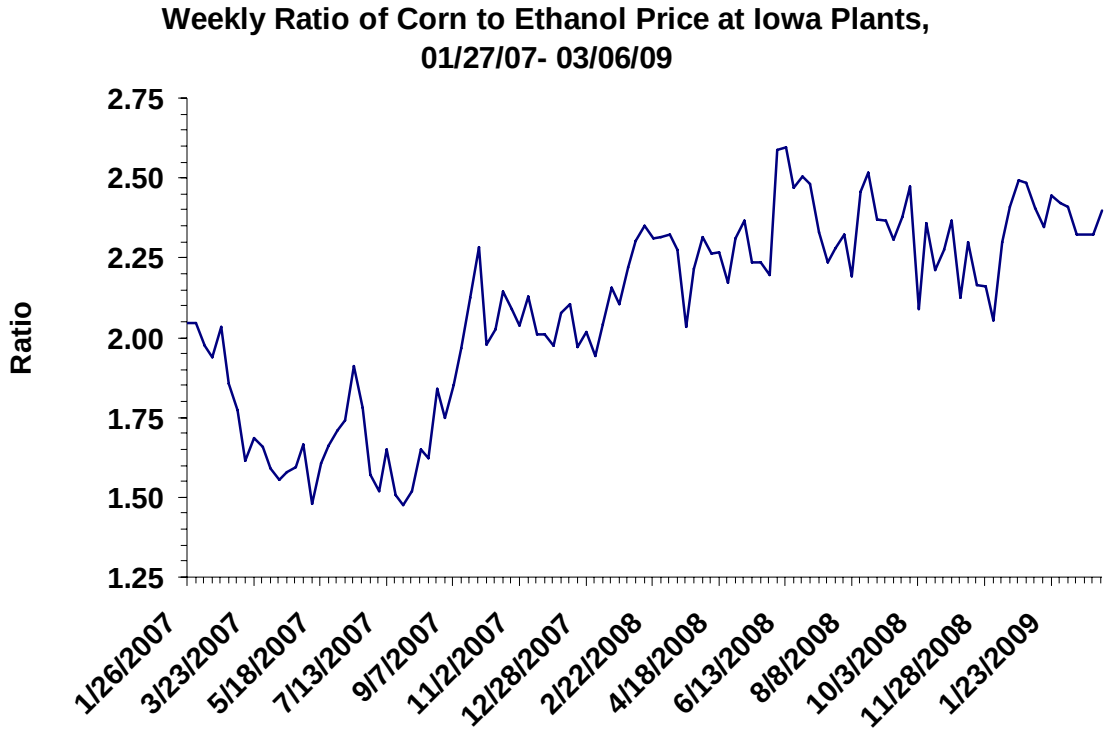
One approach to the problem is to use _____ prices to forecast ethanol prices for 2009/10 and then the historical relationship between ethanol and corn prices





Note: The historical relationship between ethanol and corn prices will be less _____ than the crude oil pricing model, but it will not account for the recent _____ prices of corn relative to ethanol

Another approach to the problem is to use ethanol futures prices to forecast ethanol prices for 2009/10 and then use only the _____ relationship between ethanol and corn prices



Comparison of 2009/10 Forecasts

Ending Stocks Model: $4.25/bu.

Crude Oil Model: $3.24/bu.

Regression Ethanol Model: $3.47/bu.

Ratio Ethanol Model: $3.78/bu.

Futures Price Model: $3.73/bu.

Bullish or Bearish????