Chapter 1
Introduction and Summary

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The U.S. ethanol boom – what are the causes, attendant effects on Illinois and U.S. agriculture, and alternative futures? These are some of the issues addressed in this and following eight chapters of a report from the Department of Agricultural and Consumer Economics and the College of Agricultural, Consumer, and Environmental Sciences, University of Illinois.

The goal of this report is to provide objective information to Illinois stakeholders, cutting through the emotional, political and economic self-interests that often dominate discussions about ethanol production and use. The purpose of this introductory chapter is to highlight main points of the report.

Ethanol Growth

Petroleum price has driven the recent dramatic growth in ethanol production in the U.S. Low corn prices, federal and state subsidies, trade barriers, renewable fuel standards, the need to replace methyl tertiary buty1 ether (MTBE) as an additive, and new technologies have, of course, been contributing factors. But without the large increase in oil and gasoline prices that has taken place since 2002, we would not be experiencing today's ethanol boom. Figure 1 illustrates the increase in oil prices, while Figure 2 shows the attendant increase in ethanol production.

At the time of this writing, 131 ethanol plants were operating in the U.S., with a capacity to produce 7.02 billion gallons of ethanol annually. Eighty-two plants were under construction, representing a 6.45 billion gallon capacity. Combined, the 13.47 billion gallons of annual ethanol capacity represents about 4.8 billion bushels of corn.

Ethanol Production Costs and Revenues

Assuming a 12% rate of return and $4.00 per-bushel corn, the cost model used here (Chapter 4) suggests that the "break even" cost for building a new plant is $2.34 per gallon of ethanol. At $2.00 corn, the cost is $1.62. While these estimates represent break-even production "costs" of ethanol, other (non-cost) factors influence the break-even "price" of ethanol.

To find the break-even price of ethanol, the production cost is adjusted to account for (1) co-product (DDGS and CO2) value, (2) subsidies, (3) the energy value of ethanol relative to gasoline, and (4) its "additive" value as an octane booster, oxygenate, MTBE replacer, and as a renewable fuel that meets federal renewable fuels standards.

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Figure 1.

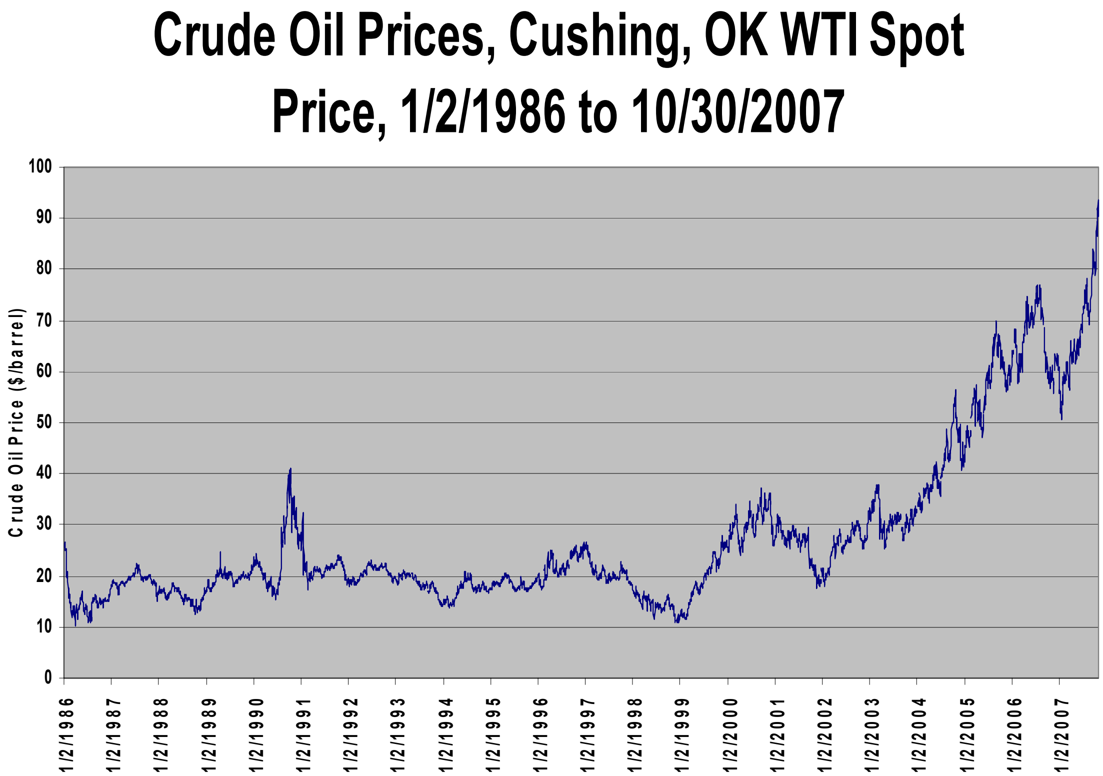
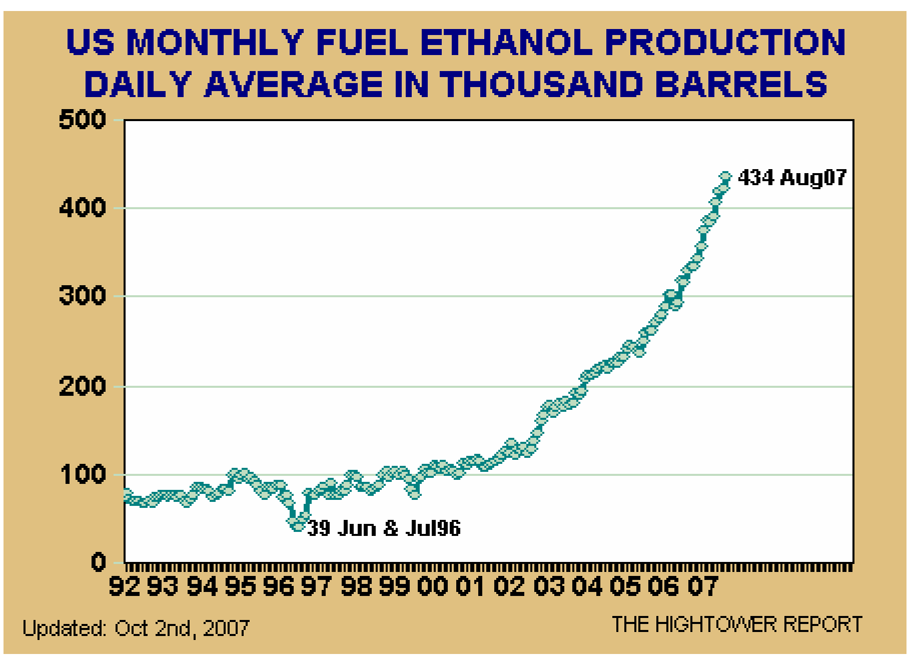


Figure 2.



Given estimates for co-product value, subsidy value, and the energy difference between ethanol and gasoline, the uncertainty of the resulting break-even price of ethanol is still large because of past variation in the "additive value" of ethanol. If the additive value is from zero to 30 cents per gallon, then our estimates indicate that the range of breakeven wholesale price of ethanol is:

* $1.62 - $2.07 per gallon when corn is $4.00 per bushel
* $0.86 - $1.31 per gallon when corn is $2.00 per bushel

In other words, if the price of corn is $4.00 and the additive value of ethanol is 30 cents, then ethanol is competitive with gasoline at the wholesale price of $1.62 per gallon. If the additive value of zero, then the breakeven price is $2.07.

Coupled with the large increase in petroleum price, the federal ethanol subsidy has also been a significant driver behind the ethanol boom. If the $0.51 per gallon tax-credit subsidy for ethanol is eliminated, then the break-even wholesale price for ethanol with $2.00 corn is at virtually the same levels shown above for $4.00 corn. The effect of the subsidy – under the pricing model in Chapter 3 – is to create a breakeven ethanol price for $4.00 corn that could only be achieved with $2.00 corn without the subsidy.

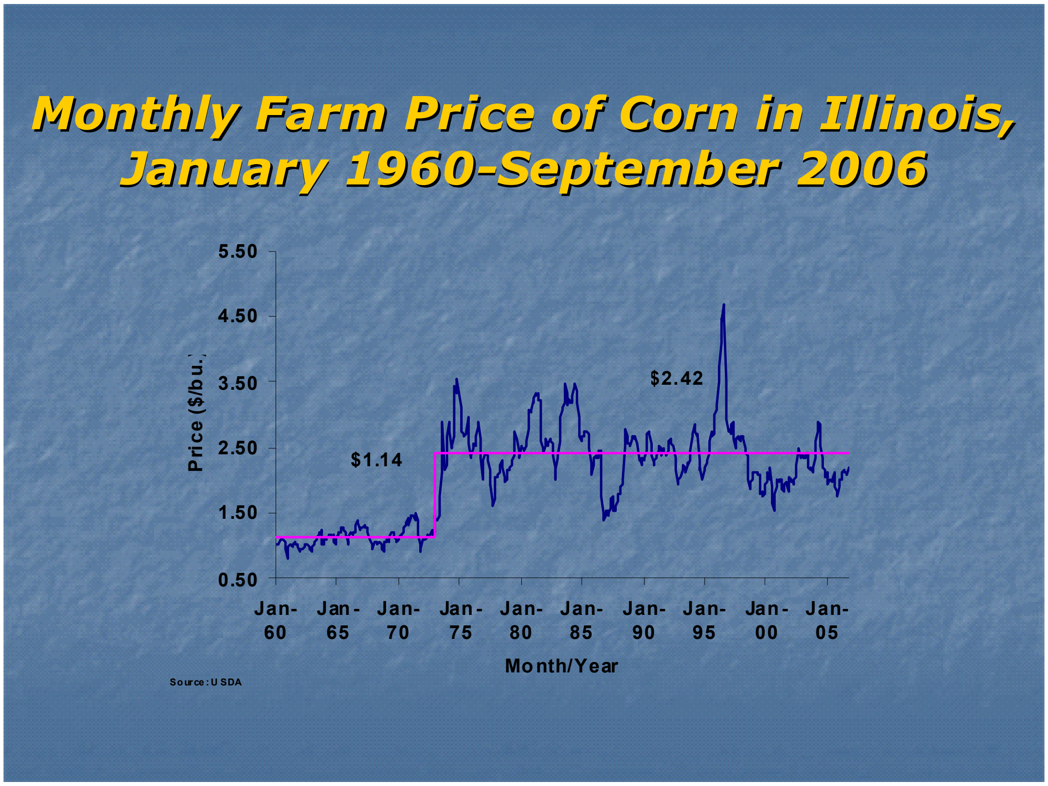
Corn Price and Attendant Effects

The long term effect of ethanol production on U.S. corn price is driven mostly by the long term price expectation of oil/gasoline. If, for example, the long-term price expectation for crude oil is $60 per barrel with an attendant wholesale price of gasoline of $2.00 per gallon, the implied break-even corn price that generates a 12% return from producing ethanol is, under reasonable assumptions, about $3.50 per bushel. Because of industry entry/exit arguments presented in Chapter 2, this $3.50 becomes the new "equilibrium" long-term price of corn.

Given the prices shown in Figure 3, it could be postulated that the "long-term" corn price since the mid 1970's has been about $2.40 per bushel until recently. A new long-run price of $3.50 would represent about a 50% increase. It is argued in this report that two significant impacts of a 50% increase in corn price (and attendant increase in other crop prices) in the U.S. will be (*i*) food (meat in particular) price increases, with relatively little decrease in consumption and (*ii*) a fall in crop exports.

Production of other crops (soybeans, wheat, cotton ...) will fall because of the change in their price relative to corn. While the large increase in demand for corn will cause the absolute price of, say, soybeans to increase, the relative increase will not be as large as that for corn. The 'fight" for U.S. acres under a high oil-price scenario will involve mostly those corn and soybean acres whose incremental production are serving the export market. Ultimately, the market will find the levels of competing (non-ethanol) uses of corn and competing uses of land for non-corn production where the incremental value of the competing use is at the new equilibrium corn price. For example, the value of corn for U.S. livestock feed will equal the new long term equilibrium price; the value of corn for foreign livestock feed (export demand) will be at the

Figure 3.



equilibrium price; and the risk-adjusted value of growing soybeans on a potential corn acre will equal the value of growing corn on that acre at the new equilibrium price.

In addition to oil price, other "ethanol factors" contributing to the long-term prices and quantities of crops include the nature of government subsidies; the magnitude of the ethanol import tariff; the ability to use more than a 10% mix of ethanol and gasoline; changes in ethanol's additive value caused by, for example, changes in federal renewable fuels standards; characteristics of non-ethanol corn demand; domestic as well as foreign crop supply responses; and advances in technologies using non-corn feedstocks for ethanol manufacturing.

Estimates of new equilibrium prices and quantities are made under a high level of uncertainty. But, fundamentally, we contend here that the new prices and quantities will be driven mostly by the long-run expectation of crude oil price, the foreign demand for crops, foreign crop-supply responses, and significant policy changes involving allowable ethanol mix, the blending tax credit (or other forms of subsidy), and/or import tariffs.

The effect of ethanol production is arguably on both crop price level and variability. The "inelastic" demand for corn by ethanol manufacturers is such that the variability of corn prices will presumably increase, particularly over short periods of time. These short-term effects are illustrated in Chapter 2, where price changes under current conditions are estimated under highly probable corn-supply changes. Current farm-bill price support levels will not reduce this variability.

The Ethanol Plant: Economics and Local Impacts

Chapter 3 provides an overview of the dry-milling production process, and estimates the cost of building new ethanol plants as well as the cost of producing ethanol in those plants, using corn as the feedstock. The resulting spreadsheet program can be found and used at http://www.agmrc.org/NR/rdonlyres/CBD4DE-8DA0-44F6-A9AE-02320DBF99F6/0/e. It can be used to estimate "break even" prices of corn, given different ethanol prices, desired rates of return to equity, and other parameters. Or, other types of sensitivity analyses can be conducted by varying input costs and mapping the resulting costs of ethanol production.

Chapter 4 presents a case study that explores the financial risks and returns of a hypothetical ethanol plant in east central Illinois. The main objective of the case study is to illustrate the factors that impact the short- and long-term profitability and financial performance of the plant. Also illustrated is an economic framework to measure risks and returns for debt capital providers, and a tool to monitor the economics of investing in a dry mill ethanol plant. Access to the model is at http://www.farmdoc.uiuc.edu/ .

The implications of constructing a plant for the local economy are examined in Chapter 5. This analysis represents the first ethanol study to use County Business Patterns data. After identifying current location patterns, an input-output analysis is done for three prototypical Illinois ethanol plants – located in rural, micropolitan and metropolitan communities. Most ethanol plants are in rural or mixed rural counties and based around a town with a population greater than 10,000. Railroad access is critical, as are adequate highways.

Economic impact analyses are conducted for three proposed Illinois ethanol plants. The three counties have different levels of urbanization, illustrating the range of impacts an ethanol plant can have on the local economy, given the economy's size. Output multipliers across the three counties are similar, while the job multipliers are higher in the metropolitan and micropolitan communities. The local impact is higher in the communities which provide more inputs. Under the most favorable assumptions involving corn price premium and the largest employment effect is about 280 jobs in Kankakee County.

Given the relatively small economic impacts of a typical ethanol plant, communities should carefully consider how much enticement should be offered to attract a plant. The ability to recover these enticements or subsidies may not exist.

Distillers Dried Grains with Solubles

A co-product of dry-milled corn-based ethanol is distillers dried grains with solubles (DDGS), which can be fed to livestock. Chapter 6 summarizes the nutrient content of DDGS in terms of level and variability, and then reviews its use for dairy cattle, beef cattle, swine, and poultry. It is estimated that of the DDGS that are used for livestock feed, 82% will be consumed by cattle, 7% by swine, and 11% by poultry.

The substitution of DDGS for corn and soybean meal is illustrated under assumptions about the magnitude of increase in ethanol production and the supply response in the livestock industry to higher feed costs. There are signs to date that the increased ethanol production is causing some migration of cattle feeding into Iowa and Nebraska, but not into the eastern Corn Belt.

Cellulosic Feed Stocks

When corn is used as the feed stock for ethanol production, sugar from starch is fermented and alcohol is distilled. Alternatively, sugar can be extracted from cellulose (plant fiber from, for example, switch grass, corn stover, or miscanthus) for ethanol production. While the present technology for using cellulose is costly relative to starch-based technology, it is receiving considerable political interest and research interest because:

- cellulose does not present the direct "food versus energy" tradeoff, although this view does not always recognize the indirect tradeoff through land use,
- cellulose offers the potential to use about one-half to one-fourth the land needed when corn is used,
- cellulose is, arguably, better suited for more marginal land, when compared to corn, and
- cellulose offers increased carbon sequestration and other environmental advantages.

The science of using alternative feed stock technology is reviewed in Chapter 7. Some of the economics of using cellulose are offered in Chapter 8. Although much research is needed, tentative cost estimates of using cellulose are compared to corn-based costs, when accounting for feed stock production, storage, transportation, and processing; the opportunity cost of land; co-products; and carbon sequestration.

For example, when corn is $3.50 per bushel, preliminary estimates suggest that it costs $0.60 per gallon more to make ethanol from miscanthus than from corn. When corn is $2.00 per bushel, it is suggested that the cost of miscanthus-based ethanol is $0.90 more than corn-based ethanol. In the case of miscanthus, carbon valuation does not add significantly to its advantage.

Among the cellulosic feed stocks considered, corn stover and miscanthus seem to offer the most promise.

Ethanol Policy and Politics

The final chapter reviews some of the policies and politics associated with ethanol in terms of (1) the "nuts and bolts" of how the policies work, (2) the effects of ethanol policy, and (3) some of the politics that drive ethanol policy.

Two significant impacts of ethanol policies involve the increase in land value and the investment by private industry in ethanol. Both impacts have been induced in part by government support, and this support may be politically difficult to discontinue. A fundamentally important question is whether the benefits from these impacts outweigh the costs, from a societal standpoint.