



A Solid Year for Ethanol Production Profits in 2022

Scott Irwin

Department of Agricultural and Consumer Economics
University of Illinois

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The U.S. ethanol industry entered 2022 on a high, with weekly profits just missing a new all-time high in November 2021. Like all other facets of the commodity business, the ethanol industry was rocked by the start of hostilities in Ukraine in February 2022. In this environment of extraordinary volatility, it was far from clear how the U.S. ethanol industry would fare. The purpose of this article is to estimate the profitability of U.S. ethanol production for the 2022 calendar year and assess how successfully the industry navigated the extraordinary volatility in commodity markets.

Ethanol Plant Model

A model of a representative Iowa ethanol plant is used to track the profitability of ethanol production. It is the same basic model of a representative ethanol plant that has been used in earlier *farmdoc daily* articles on the subject (e.g., [January 29, 2020](#); [January 27, 2021](#); [February 10, 2022](#)). The [original version of the model](#) was developed by Don Hofstrand of Iowa State University and was meant to be representative of a typical ethanol plant constructed in the mid-2000s. There is certainly substantial variation in capacity and production efficiency across the industry and this should be kept in mind when viewing profit estimates based on the model.

Some of the original assumptions of the model have been changed based on additional analysis or changing data availability. Current model assumptions include:

- Dry mill plant constructed in 2007
- 100 million gallon annual ethanol production capacity
- Plant construction costs of \$2.11 per gallon of ethanol production capacity
- 40% debt and 60% equity financing
- 8.25% interest on 10-year loan for debt financing, with the loan fully repaid in 2017

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- A total of \$0.21 fixed costs per gallon of ethanol produced through 2017 and \$0.15 per gallon in 2018-2022 (the decline is due to the loan payoff)
- Non-corn, non-natural gas variable costs (including denaturant) of \$0.21-\$0.26 per gallon in 2007-2011
- Non-corn, non-natural gas variable costs excluding denaturant of \$0.16 -\$0.21 per gallon after 2011
- Variable denaturant costs after 2011 computed as 2 percent of wholesale CBOB price
- 82.5 cubic feet of natural gas per bushel of corn processed
- Netback (marketing) costs of \$0.05 per gallon of ethanol and \$4 per ton of DDGS
- Extraction and marketing costs of \$0.05 per pound of corn oil

Operating efficiency assumptions represent a key component of the model. These have been revised substantially over time as new data has become available. The latest assumptions are based on analysis of the operating efficiency of the U.S. ethanol industry in a recent *farmdoc daily* article ([March 1, 2023](#)). Specifically, the current assumptions for physical conversion rates are as follows:

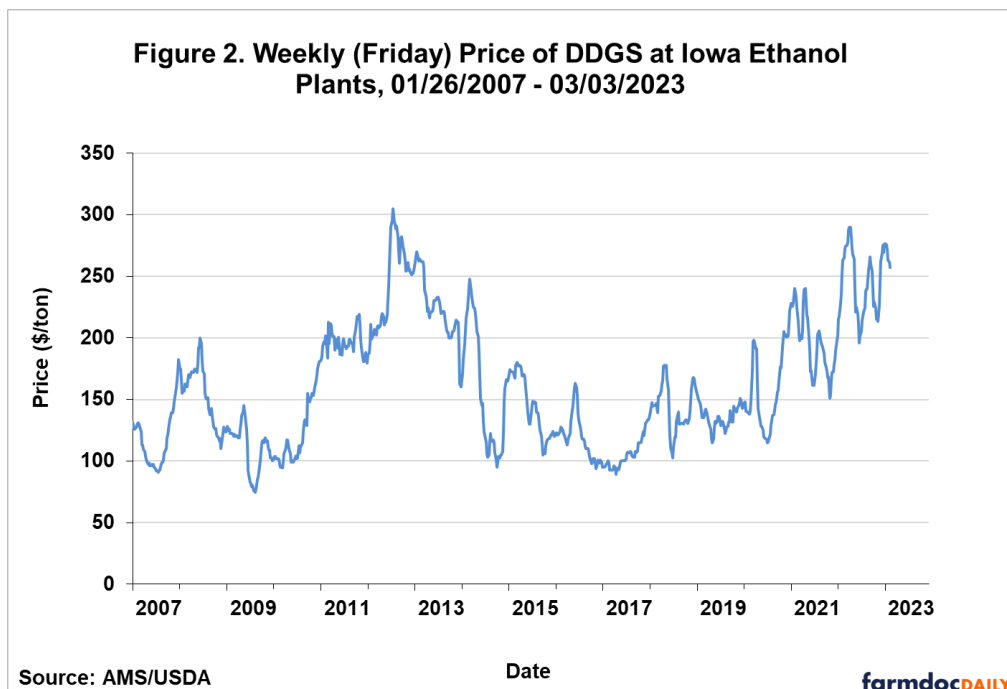
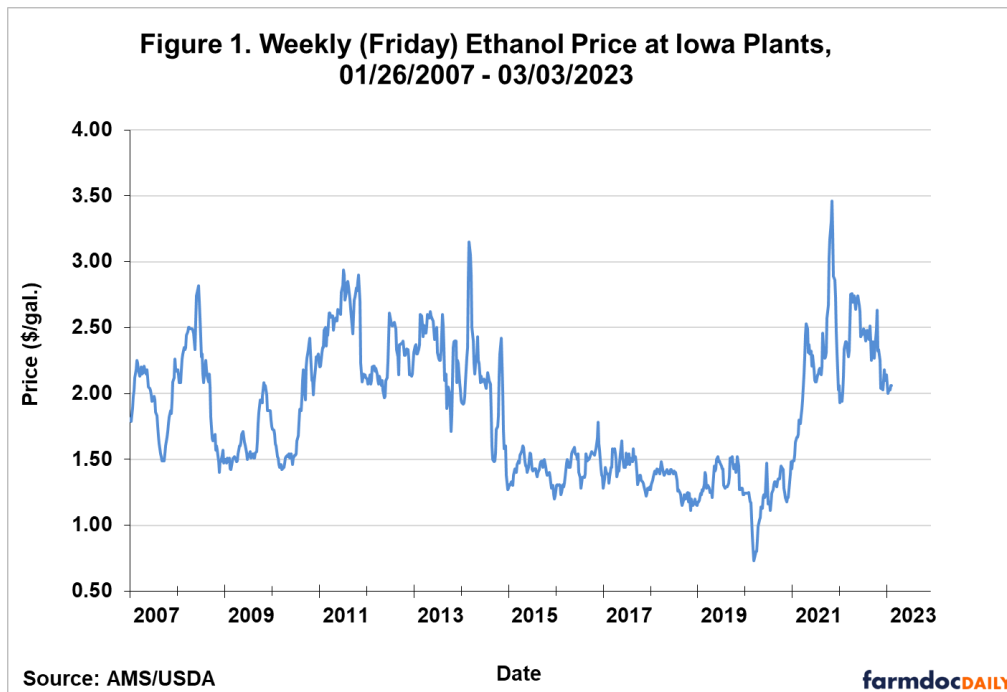
- 2.75 gallons of ethanol (including denaturant) produced per bushel of corn processed over 2007-2011; 2.80 gallons of ethanol per bushel of corn over 2012-2014; 2.85 gallons of ethanol per bushel of corn over 2015-2018; and 2.90 gallons of ethanol per bushel of corn over 2019-2022
- 17.75 pounds of DDGS produced per bushel of corn processed over 2007-2011; 17.00 pounds of DDGS per bushel of corn for 2012-2016; 16.50 pounds of DDGS per bushel of corn over 2017-2018; 16.00 pounds of DDGS per bushel of corn in 2019; 15.75 pounds of DDGS per bushel in 2020-2021; and 16.00 pounds of DDGS per bushel in 2022
- 0.55 pounds of corn oil per bushel of corn processed over 2012-2014 (start extracting January 2012); 0.60 pounds of corn oil per bushel of corn processed in 2015; 0.70 pounds of corn oil per bushel of corn processed in 2016; 0.75 pounds of corn oil per bushel of corn processed in 2017-2019; 0.80 pounds of corn oil per bushel of corn processed in 2020; 0.85 pounds of corn oil per bushel of corn processed in 2021; and 0.90 pounds of corn oil per bushel of corn processed in 2022.

To track plant profitability over time, weekly [corn](#), [ethanol](#), and [DDGS](#) prices at Iowa ethanol plants are collected from the USDA Agricultural Marketing Service starting in late January 2007. Crude corn oil prices for the Midwest are available from OPIS. Natural gas costs over 2007 through March 2014 are based on monthly industrial prices for Iowa available from the EIA. Due to a change in the behavior of the industrial price series, starting in April 2014 natural gas costs are based on monthly electric power consumer prices for Iowa, also from the EIA.

Analysis

Figures 1, 2, and 3 present the three components of ethanol production revenue on a weekly basis from January 26, 2007 through March 3, 2023. Figure 1 shows the weekly price of ethanol at Iowa plants. The figure reveals that prices in early 2022 were down substantially compared the all-time high in November 2021 of \$2.46 per gallon. Then in February 2022, Russia invaded Ukraine and ethanol prices followed grain and crude oil prices higher. This rebound extended into June, when ethanol prices hit a high for year of \$2.74 per gallon. Despite the war in Ukraine, prices steadily declined the rest of the year, ending up near \$2.00. In comparison, Figure 2 shows that weekly DDGS prices tended to increase throughout most of 2022. Figure 3 reveals that weekly corn oil prices exploded in the first half of 2022, reaching an all-time high of \$1.01 per pound during June 2022. Corn oil prices declined precipitously from this rarified level and ended the year under \$0.70 per pound. In sum, output prices for ethanol producers were highly volatile in 2022.

The main input cost of producing ethanol is corn (about 80 percent), and Figure 4 shows that the price of corn spiked in 2022 after the outbreak of the war in Ukraine. In June, the price of corn briefly exceeded \$8.00 per bushel, which had happened only one time before in the summer of 2012. Prices then went on an extended decline through the remainder of the year, but generally held above \$7.00 per bushel, still a very high price level historically.



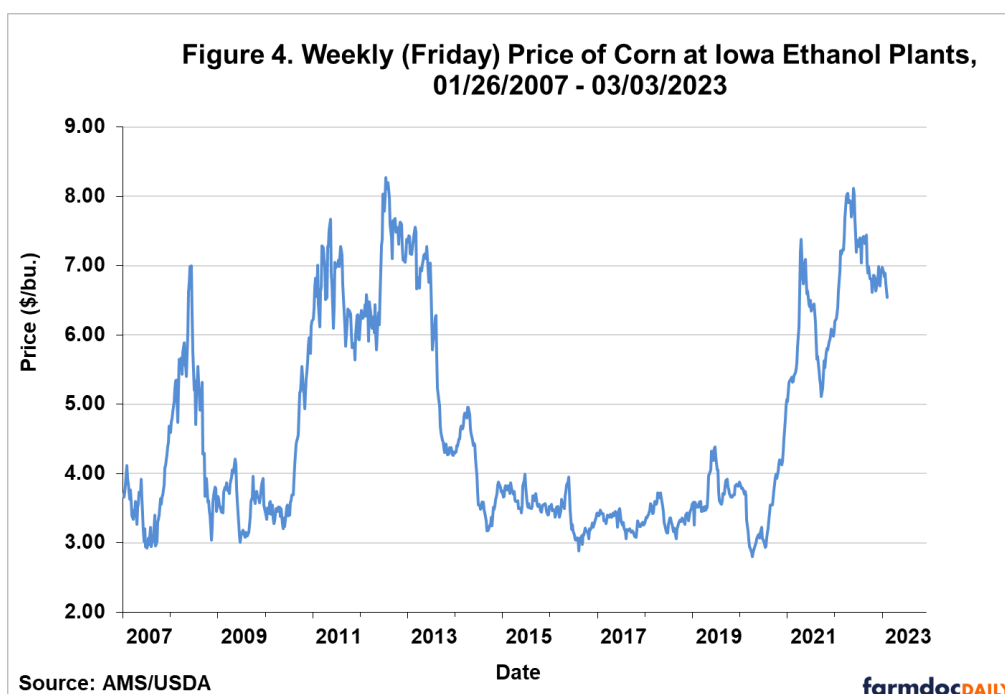
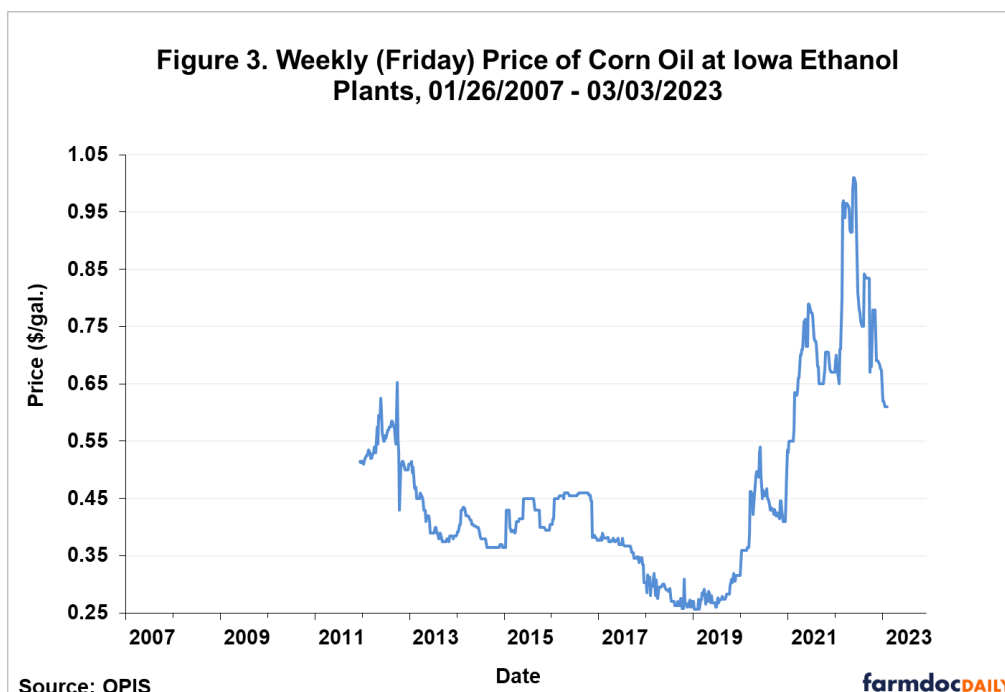
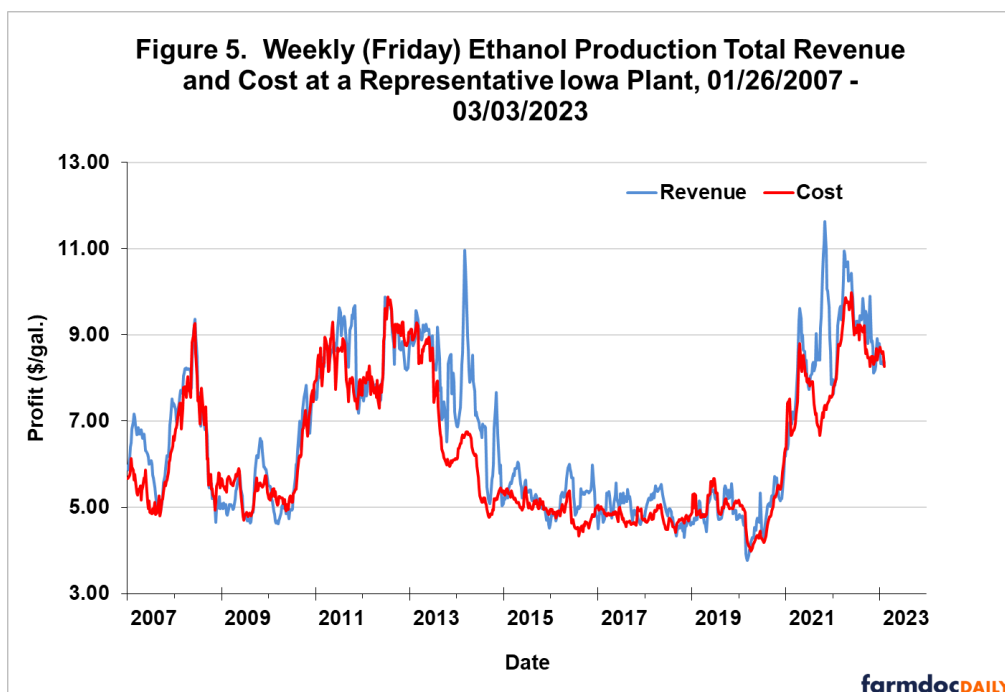
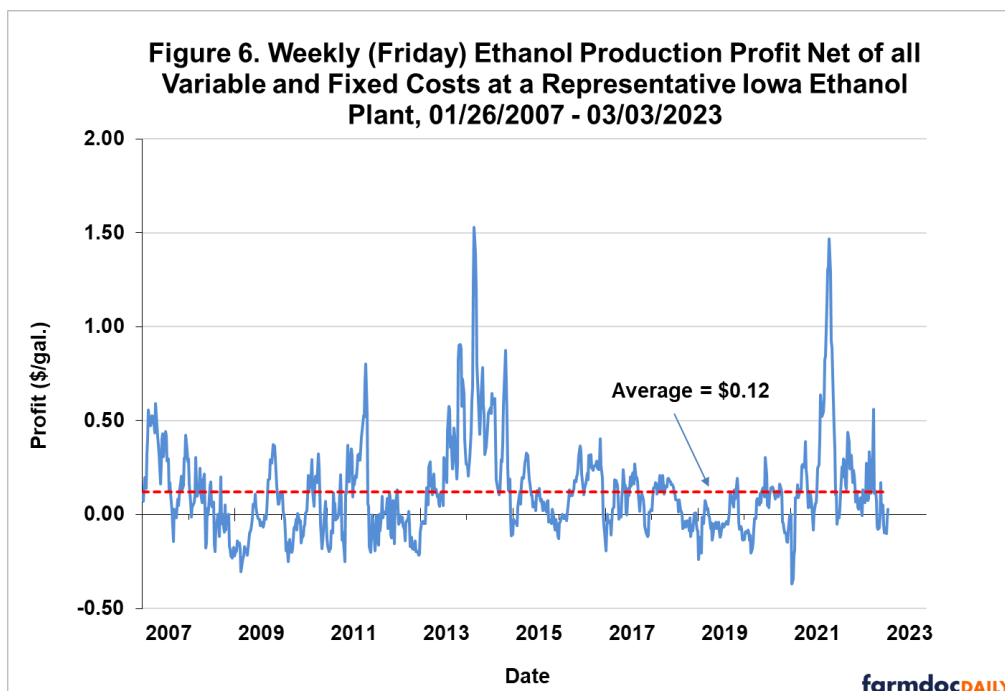


Figure 5 presents combined weekly total revenue for ethanol, DDGS, and corn oil and weekly total variable and fixed costs for the representative Iowa plant. While revenue consistently exceeded \$9.00 per gallon during the year, costs were generally not far behind. As a result, revenue and costs were much more closely matched in 2022 than in 2021, when the gap between the two reached historically record high levels. The fairly close match of revenue with cost in 2022 is the norm in most years since 2007.

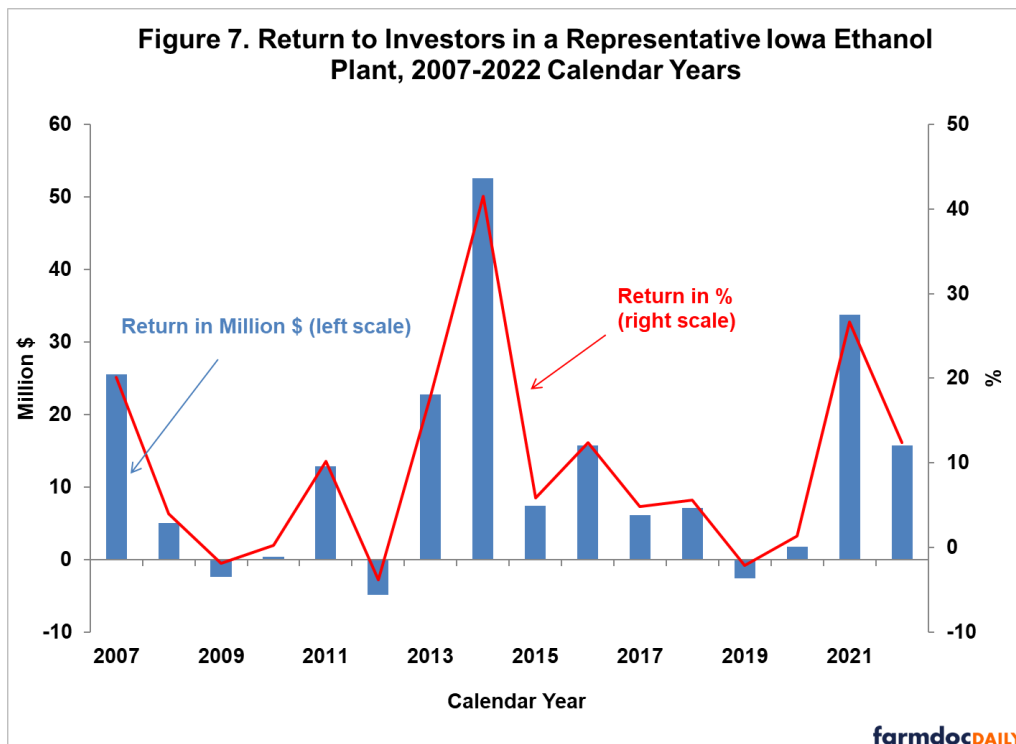


Weekly ethanol production profits net of all variable and fixed costs is shown in Figure 6. This is simply the difference between revenue and cost presented in Figure 5. Net profits oscillated between roughly breakeven and \$0.50 per gallon throughout 2022. The highest profit for the year was \$0.56 in November and the lowest was -\$0.08 in December. Profits turned negative in December 2022 and have struggled to get back in the black since then. The average net profit for the entire calendar year in 2022 was \$0.16 per gallon, marginally higher than the long-term historical average of \$0.12. So, despite the extraordinary volatility of commodity prices in 2022, net profits for ethanol producers were in the black most of the year.



It is also useful to consider ethanol production profitability aggregated over an annual horizon for 2007-2022, as shown in Figure 7. Profits are presented in terms of both total pre-tax net returns and percent returns to equity. The net profit of \$15.7 million in 2022 was solidly in the top half of years. It was also the ninth profitable year in the last decade. With the addition of 2022 profits, the total cumulative (pre-tax)

return to equity holders for the 2007-2022 period stands at \$196.8 million, \$70.2 million more than the assumed original equity investment for the plant of \$126.6 million. We can use the average net profit for the representative plant to make a rough estimate of profit for the operating segment of the U.S. ethanol industry in 2022. Assuming all operating plants in the industry earned the average net profit for the representative plant of \$0.16 per gallon and that total ethanol production for the U.S. was 15.4 billion gallons in 2022, total (pre-tax) profit for all operating ethanol plants can be estimated at \$2.5 billion. Again, indicative of a solid if not spectacular year for ethanol producers.



Lastly, the percent return to equity holders provides useful information on the attractiveness of investment in ethanol plants relative to other investments. The average return was 9.7 percent over 2007-2022 and the standard deviation, a measure of risk, was 12.1 percent. By comparison, the average return for the stock market over this period, *as measured by the S&P 500*, was 10.2 percent and the associated standard deviation was 18.5 percent. The ratio of average return to standard deviation provides one measuring stick of an investment's return-risk attractiveness, and on this measure the ratio for ethanol investment, 0.80, is higher than the ratio for the stock market as a whole, 0.55. From this standpoint, ethanol plants have a respectable record of investment performance over the last 16 years.

Implications

The war in Ukraine took center stage in 2022 and it led to extraordinary volatility in nearly all commodity prices. Ethanol producers in the U.S. managed to weather the price shocks reasonably well, with average profits for the year of \$0.16 per gallon, marginally higher than the long-term average of \$0.12. Basically, ethanol, DDGS, and corn oil prices were able to move to historically high enough levels to offset record high corn prices. In dollar terms, the net profit for a representative ethanol plant was \$15.7 million in 2022, and this was solidly in the top half of years. It was also the ninth profitable year in the last decade. With the addition of 2022 profits, the total cumulative (pre-tax) return to equity holders for the 2007-2022 period stands at \$196.8 million, \$70.2 million more than the assumed original equity investment for the plant of \$126.6 million.

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