

**CARD Policy Brief 11-PB 5**  
**April 2011**

## **The Impact of Ethanol and Ethanol Subsidies on Corn Prices: Revisiting History**

**by Bruce A. Babcock and Jacinto F. Fabiosa**

The authors thank the David and Lucile Packard Foundation for support for model development at CARD and the Food and Agricultural Policy Research Institute at Iowa State University.

Published by the Center for Agricultural and Rural Development, 578 Heady Hall, Iowa State University, Ames, Iowa 50011-1070; Phone: (515) 294-1183; Fax: (515) 294-6336; Web site: [www.card.iastate.edu](http://www.card.iastate.edu).

© Authors. The views expressed in this publication do not necessarily reflect the views of the Center for Agricultural and Rural Development or Iowa State University.

Iowa State University does not discriminate on the basis of race, color, age, religion, national origin, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. veteran. Inquiries can be directed to the Director of Equal Opportunity and Compliance, 3280 Beardshear Hall, (515) 294-7612.

## **Executive Summary**

The rapid rise in corn prices that began in the fall of 2006 coincided with exponential growth in U.S. corn ethanol production. At about the same time, new ethanol consumption mandates were added to existing ethanol import tariffs and price subsidies. This troika of subsidies leads critics to view the ethanol industry as being beholden to subsidies, which then leads to the conclusion that ethanol subsidies lead to high corn prices. But droughts, floods, a severe U.S. recession, and two general commodity price surges have also occurred since 2006. It simply is wrong to assume that none of these factors has influenced corn prices.

While we cannot rerun history to see what corn prices would be like today without ethanol subsidies, we can rewrite history in a computer model to estimate what impact subsidies have had on market prices. The model would first need to be calibrated so that its solution re-creates what actually happened in agricultural markets. Then it would need to be rerun after government incentives to produce and consume corn ethanol are removed from the model's equations. The resulting prices can then be compared to the historical record to estimate the market impacts of ethanol subsidies. This is exactly what we did for the 2005 to 2009 corn marketing years using the same model of the agricultural sector that CARD research staff used for the Environmental Protection Agency to estimate land-use changes from biofuels. To further isolate the effects of ethanol on commodity prices, we also ran a scenario in which we froze ethanol production at 2004 levels.

A number of issues were clarified through this exercise. First, the general pattern of corn prices that we saw in the historical period—increasing prices in 2006 and 2007, a price spike in 2008, followed by a sharp price decline in 2009—would have occurred without ethanol subsidies or even if corn ethanol production had not expanded. Second, investor fervor for corn ethanol in 2005, 2006, and 2007 would have occurred even without subsidies because a combination of cheap corn, a phase-out of MTBE, and higher crude oil prices made ethanol profitable. Thus, ethanol production would have expanded quite rapidly even without subsidies.

Using the 2004 corn price of \$2.06 per bushel as a reference, actual corn prices increased by an average of \$1.65 per bushel from 2006 to 2009. Only 14 cents (8%) of this increase was due to ethanol subsidies. Another 45 cents of the increase was due to market-based expansion of the corn ethanol industry. Together, expansion of corn ethanol from subsidies and market forces accounted for 36% of the average increase that we saw in corn prices from 2006 to 2009. All other market factors accounted for 64% of the corn price increase.

**Keywords:** corn ethanol, corn prices, ethanol subsidies.

# **The Impact of Ethanol and Ethanol Subsidies on Corn Prices: Revisiting History**

**By Bruce A. Babcock and Jacinto F. Fabiosa**

How much does corn ethanol affect food prices? This question never seems to be satisfactorily answered. Opponents of ethanol often argue that the ethanol industry only exists because it is subsidized, that its existence increases the price of corn, and that food prices are higher because corn is an important food ingredient and livestock feed. Ethanol supporters argue that higher corn prices have a small impact on food prices because the value of corn makes up such a small share of the final consumer food dollar. Some dispute the link between ethanol production and corn prices when they argue that the production of ethanol also produces distillers grains—a valuable livestock feed—and that U.S. farmers have been able to keep up with increased corn demand by increasing yields and planting more acres of corn.

It is disingenuous to argue that there is no link between ethanol production and corn prices. And there is a direct link between higher corn prices and food costs because higher corn prices translate directly into higher feed costs, which eventually translate into higher prices for meat, eggs, and dairy products. However, the extent to which higher corn prices are caused by ethanol subsidies is difficult to calculate. In stressing the importance of the blender tax credit in keeping the demand for ethanol (hence corn) strong, the Renewable Fuels Association—one of the important lobbyists for the corn ethanol industry—gives credence to the arguments of its opponents who link ethanol to higher food prices. But the demand for ethanol has also been buttressed by blending mandates, high oil prices, and the phase-out of MTBE, a source of oxygenate for gasoline made from petroleum. Furthermore, the price of corn is not solely determined by ethanol. The demand and supply for feed in the United States and abroad also determine corn prices. Feed demand depends on population and income levels. Feed supply depends on weather in important growing areas of the world. Thus all of these factors need to be taken into account in determining the impact of ethanol and ethanol subsidies on corn prices.

## **Estimating Corn Prices Without Ethanol**

One method for estimating the impacts of ethanol on corn prices is to “backcast” corn prices using an economic model of the agricultural sector. A backcast is an estimate of what would have happened in the past had some historical event happened differently. Many studies include projections of the impact of expanded ethanol on future corn prices. The authors of these studies typically estimate impacts by first using an economic model to project the demand and supply of corn under a baseline set of conditions. Supply and demand for corn are then projected using the same model and set of conditions except that the demand for corn ethanol is increased. The price projections are then compared to estimate the change in corn prices from expanded ethanol production.

The same basic procedure can be used to estimate the impact of ethanol on historical corn prices. First, the economic model is carefully calibrated so that all the crop supply and demand equations replicate the actual observed prices and production levels. To this end, all relevant supply and demand curves are shifted until their intersection occurs at the observed prices and quantities for a historical period, which is a simple procedure. For example, the average U.S. price of corn in 2008 was \$4.06 per bushel. Planted

acreage was 86 million acres and yield was 153.9 bushels per acre. Feed use was 5.182 billion bushels, exports were 1.849 billion bushels, and ending stocks were 1.673 billion bushels. These data reveal the level of demand for U.S. corn, corn yields, and the desire and ability of U.S. farmers to plant corn in 2008 relative to alternative crops. These data also reveal the net effect on U.S. corn demand from supply decisions of all other farmers in the world and the impacts of weather on crop supply in all parts of the world.

After this calibration is accomplished for all crops and all years in the backcasting period, it becomes a straightforward exercise to answer interesting “what if” questions. Insight into how ethanol production and ethanol subsidies affect corn prices can be obtained by answering the following two questions:

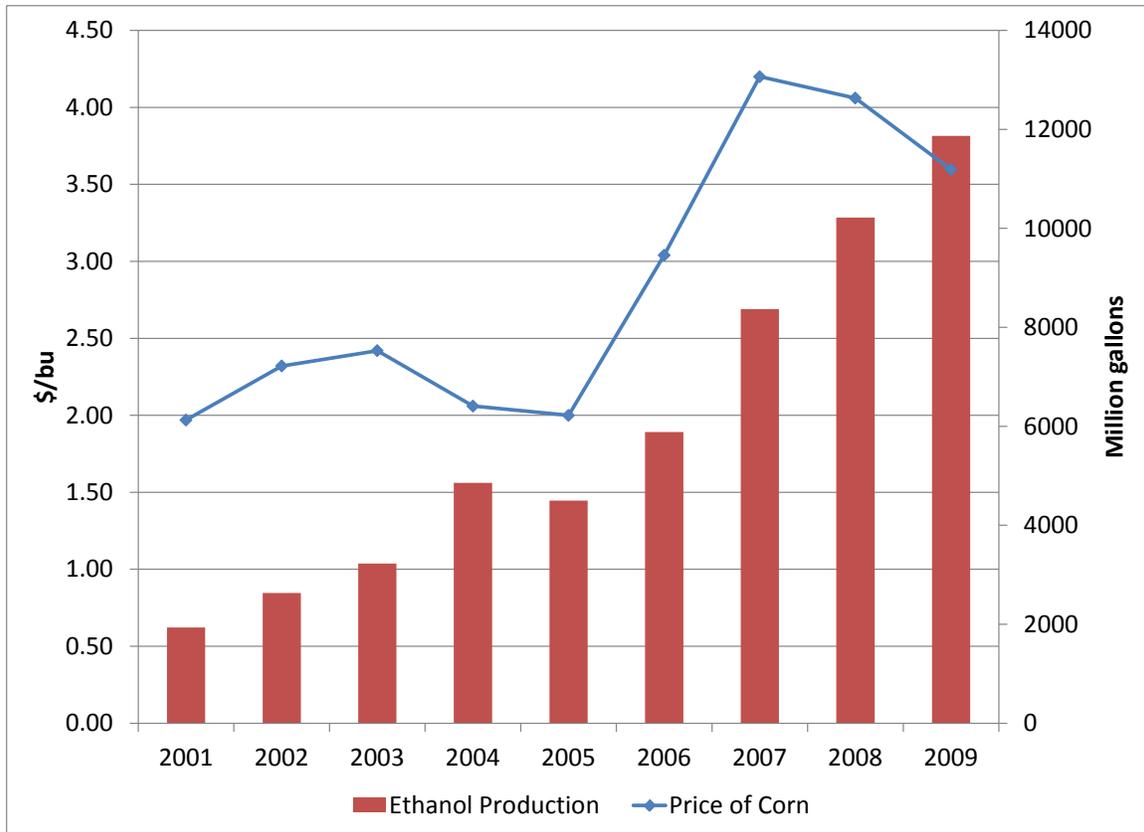
1. What would corn and other crop prices have been from 2005 to 2009 if the blender tax credit for ethanol had been abolished at the end of 2004 and if ethanol mandates had never been adopted?
2. What would corn and other crop prices have been from 2005 to 2009 if Congress had capped ethanol production at 2004 levels from 2005 to 2009?

The answer to the first question provides insight into what proportion of ethanol production was caused by mandates and tax credits rather than other economic factors. The answer to the second question provides insight into the role that all other economic factors played in determining corn prices.

The answers to these questions are sensitive to the choice of model used to conduct the study. Different models contain different assumptions about, for example, how farmers choose which crops to plant and the sensitivity of crop demand to changes in price. The model that we use to answer these questions is the same basic model that CARD researchers used to support the Environmental Protection Agency’s finding that corn ethanol and biodiesel meet the greenhouse gas targets under the current Renewable Fuel Standard. The model is a detailed model of the U.S. agricultural sector that is linked to commodity-specific models of supply and demand for all important importing and exporting countries.

### **Actual History**

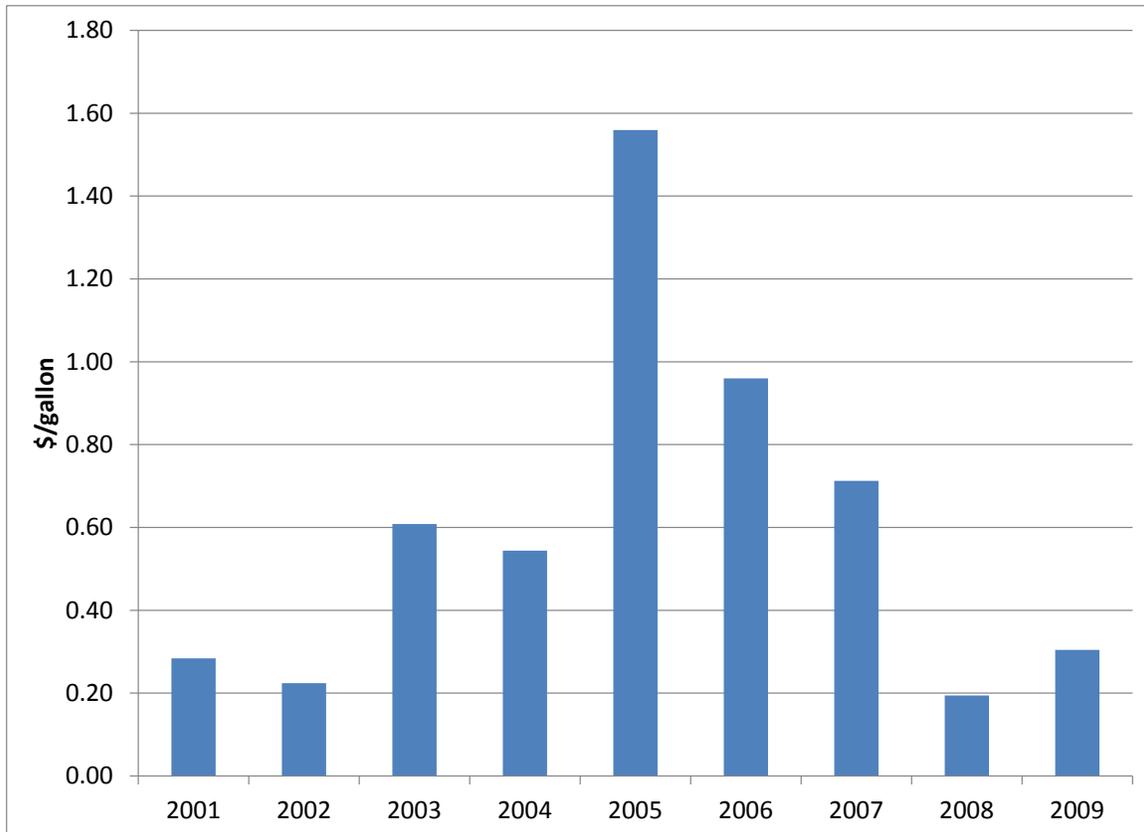
Historical corn prices and U.S. ethanol production are shown in Figure 1. The sharp increase in corn prices beginning with the 2006 crop is clear. This increase roughly coincides with the dramatic increase in ethanol production that began the same year. What seems to have happened in the fall of 2006 is that it became evident that the pace of construction of corn ethanol plants had exploded. As a result, traders increased their projections of future corn demand, so naturally the price of corn increased. But that is not all that happened in 2006. Corn yields and planted acreage in 2006 were lower than expected, which also put upward pressure on corn prices. In addition, world wheat supplies were lower in 2006 because of drought in Australia and hot weather in the European Union. These other factors need to be accounted for because, as can be seen from a close examination of Figure 1, there is not a perfect correspondence of corn prices and ethanol production. For example, corn prices in 2004 and 2005 were below 2003 levels despite higher ethanol production. The bumper crop in 2004 is largely responsible for the lower corn prices, which demonstrates the need to account for weather when determining what corn prices would have been in the past.



**Figure 1. Corn prices and ethanol production from 2001 to 2009 (marketing year basis)**

The investor fervor for ethanol that greatly expanded the U.S. capacity to produce ethanol was driven, at least in part, by tremendous returns to ethanol production before 2008. These returns are shown in Figure 2. After paying for corn, natural gas, labor, yeast and all other variable costs of production, ethanol plants made an average of \$1.58 per gallon in the 2005 corn marketing year. To put this margin into perspective, in 2005, a 100-million-gallon ethanol plant cost perhaps \$125 million to build. This means that if this 100-million-gallon plant had come online in the summer of 2005, then the plant could have been paid for in a single year. Of course, to come online in the summer of 2005, planning for the plant would have had to begin in 2002 or 2003 when margins were much lower. The large margins in 2005, 2006, and 2007, however, greatly accelerated investor interest, which led directly to large increases in production capacity in 2007, 2008, and 2009.

The wide processing margins were caused by a combination of inexpensive corn and expensive ethanol. The phaseout of MTBE as a gasoline additive in 2004 and 2005 boosted demand for ethanol as its replacement. This growth in ethanol demand combined with existing demand subsidies and a limited supply of ethanol to greatly increase ethanol prices, thus leading to the wide processing margins. The strong margins in 2006 and 2007 were due to a continuation of the subsidies and higher oil prices, which encouraged discretionary blending of ethanol as a substitute for gasoline. The crash in oil prices in the latter half of 2008 contributed to the decline in both processing margins and corn prices.

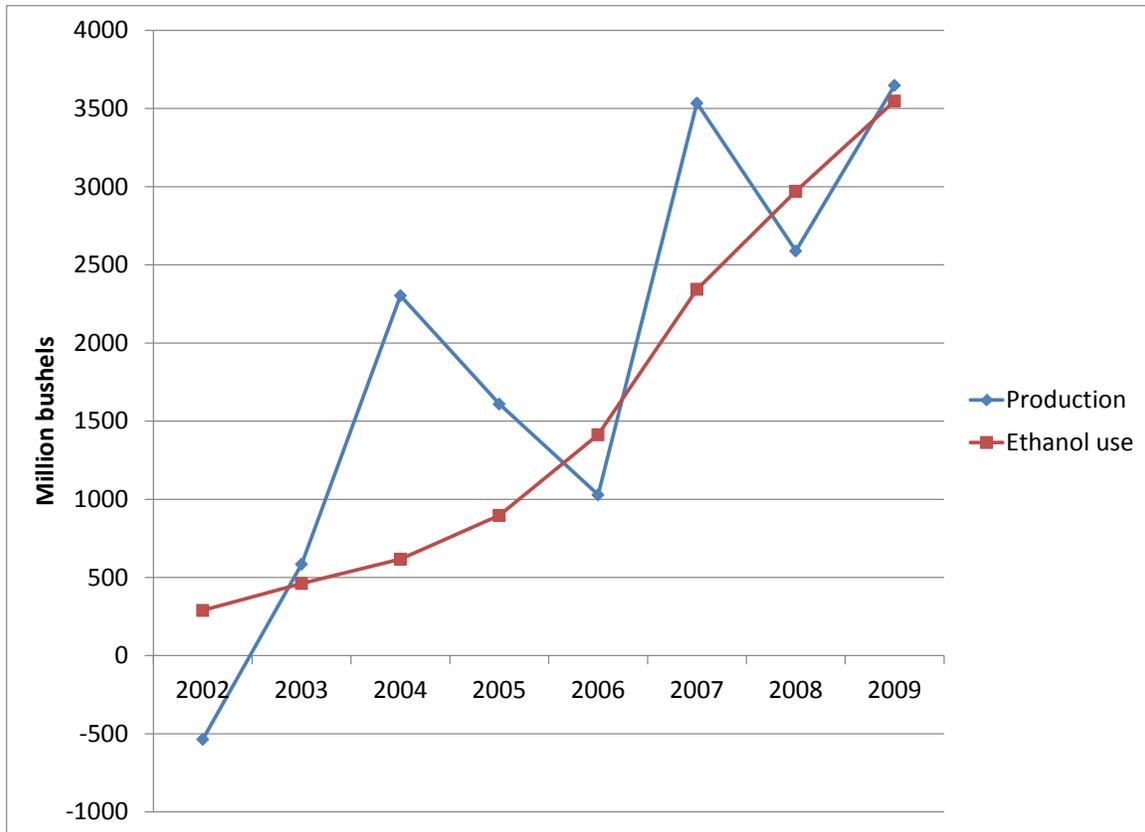


**Figure 2. Processing margins for U.S. dry mill ethanol plants (marketing year basis)**

The production of corn kept pace with the use of corn in ethanol through 2009, as shown in Figure 3. This was accomplished by increasing both yields and acreage. Harvested corn acreage increased by an average of 2.2% from 2001 to 2009. Yields increased by an average of 2.5%. Thus, the total corn supply increased by almost 5% per year over the period. Of course, farmers increased acreage only because of the corn price increase, shown in Figure 1. Also, some of the yield increase was also likely due to higher prices received since 2006.

### **What Would Have Happened Without the Subsidies?**

To estimate what the ethanol and corn situation would have been without ethanol mandates and the blender tax credit, the model was calibrated to historical conditions from 2005 to 2009, and then the model was rerun after the incentives created by the mandate and blender credit were taken out of the model's equations. By definition, the market effects of the two subsidies are included in the actual history of corn markets. Thus, a comparison of the model results without the subsidies with the actual historical observations provides an estimate of what markets would have looked like if mandates had never been adopted and if the blender tax credit had been eliminated on December 31, 2004. The model was rerun only from 2005 to 2009 because final 2010 data are not yet available.

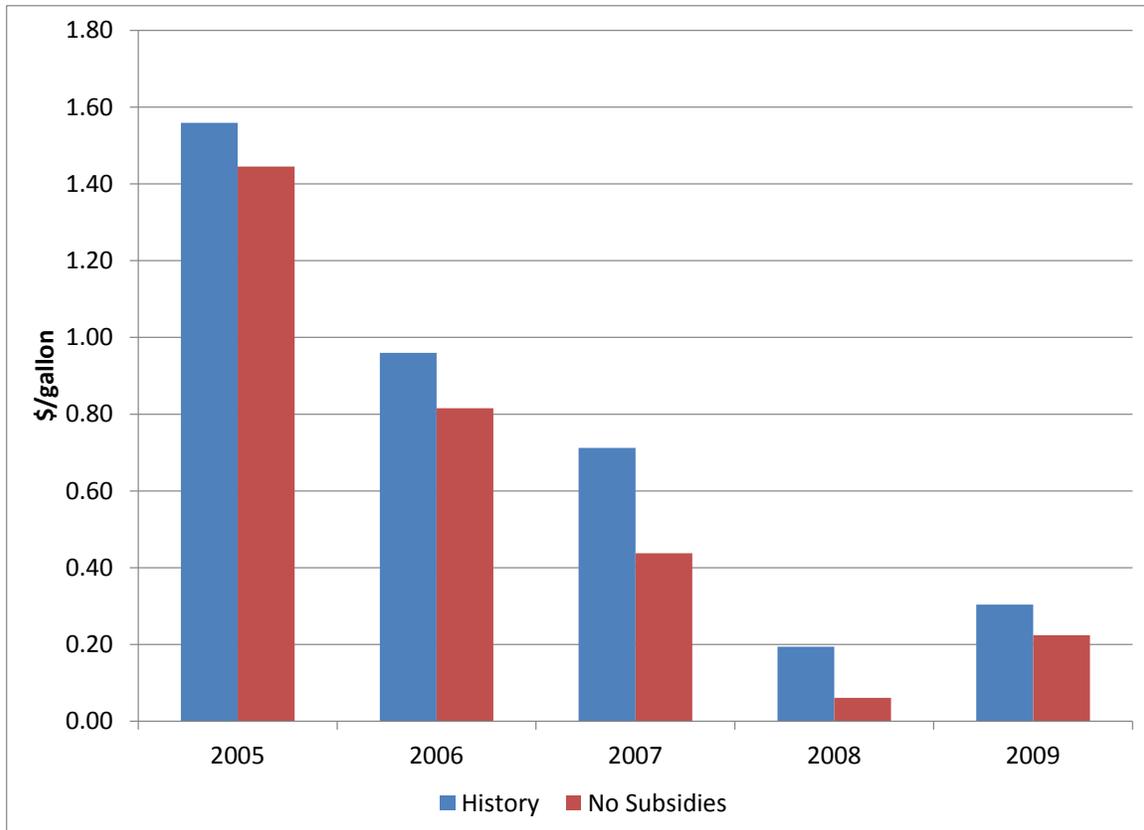


**Figure 3. Increase in production of corn and use of corn to produce ethanol since 2001**

If there had been no mandate or tax credit from 2005 to 2009, ethanol processing margins would have been lower because both policy tools work to increase the price of ethanol that plants receive. Lower processing margins, in turn, would have decreased the incentive to invest in ethanol plants, which would have held down ethanol production and the demand for corn. Lower corn prices would have resulted in fewer acres being planted, and consequently in somewhat higher corn prices. The model finds new equilibrium prices and production levels across all crops for the 2005 to 2009 period.

Because processing margins drive investment in plants, the impacts of removing subsidies on these margins are shown first, in Figure 4. Processing margins would have been lower, but only by a small amount. Wide margins in 2005 and 2006 would have continued. These wide margins imply that there still would have been strong incentives in place to build ethanol plants without the subsidies. This means that a large expansion in U.S. corn ethanol production would have occurred even if the subsidies and mandates had not been in place. The reason is that the return on investment in ethanol would have been so high that investors still would have brought their capital to the industry. Figure 5 compares historical ethanol production with what ethanol production would have been without the subsidies. As shown, the model indicates that in 2009, ethanol production would have been about 1.2 billion gallons lower without subsidies than what it was with subsidies.<sup>1</sup>

<sup>1</sup> Because the analysis begins in 2005, no accounting is done for how subsidies in previous years may have “set up” the industry for rapid expansion beginning in 2005 and 2006. Also, the



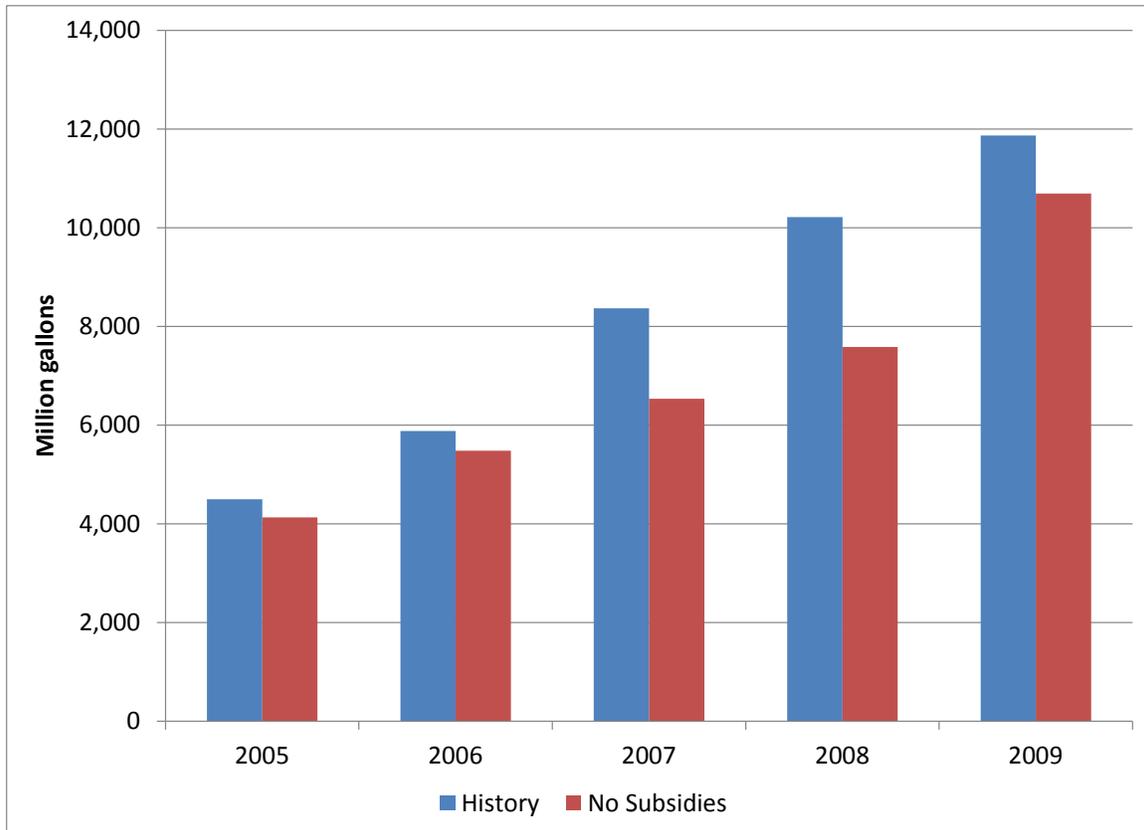
**Figure 4. Processing margins with and without ethanol subsidies**

The fact that ethanol production would have expanded even without subsidies means that corn prices and corn acreage would have also increased. Corn prices without the ethanol subsidies would have averaged only 4% less over this period than what they were. Part of the reason why corn prices would not have seen a more significant decrease is that corn acreage would have been lower without the subsidies. Acreage would have dropped by an average of about 2.8 million acres in 2007, 2008, and 2009, though it would have been largely unchanged in 2005 and 2006. This drop in corn acreage in favor of acreage planted to other crops would have somewhat counteracted the price decrease from lower ethanol demand.

These results demonstrate that ethanol subsidies have contributed to high corn prices and higher food prices since 2005, but the impacts have been small. The largest difference in corn prices, in 2007, would have been \$0.30 per bushel, or about 7%. This relatively small change in corn prices necessarily implies that the contribution of ethanol subsidies to food inflation is largely imperceptible in the United States. However, this does not mean that the contribution of ethanol to food inflation is imperceptible.

---

model's investment equation depends on processing margins only and not on investors' expectations about any U.S. commitment to a pro-ethanol policy that may have accelerated investment in ethanol plants in the historical period.

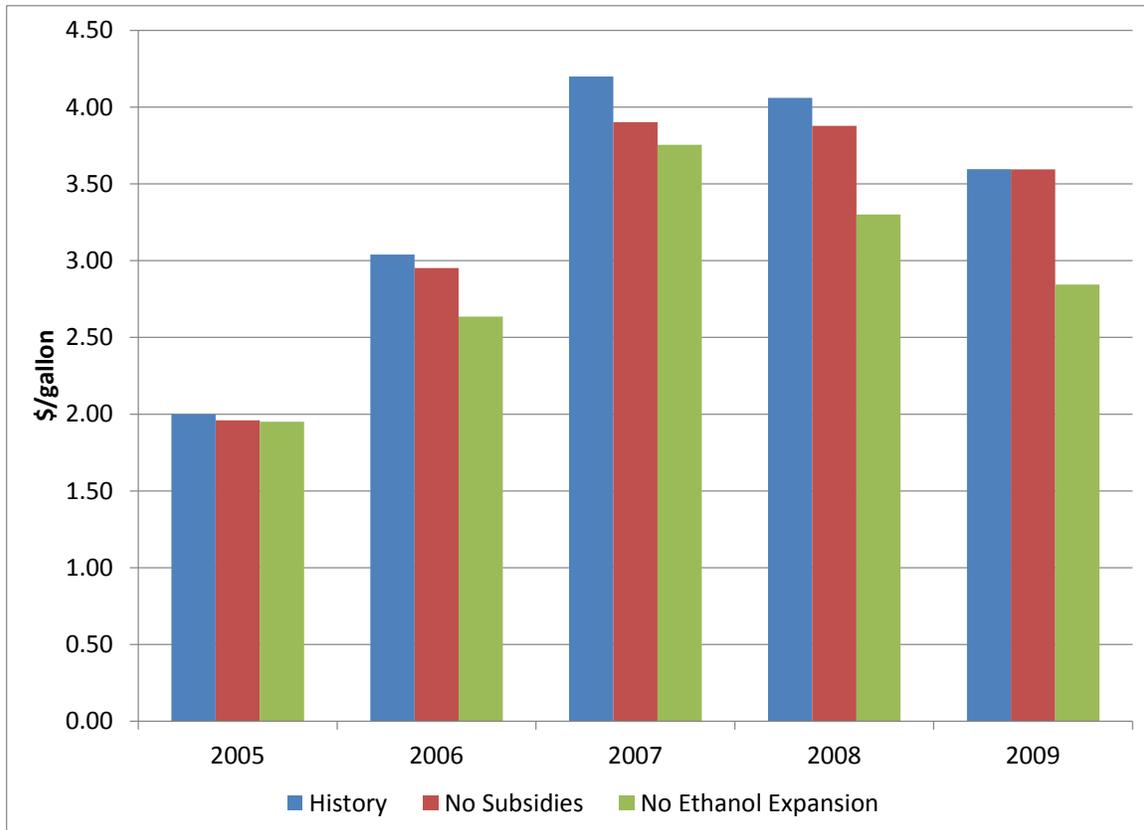


**Figure 5. Ethanol production with and without ethanol subsidies**

### **Impact of Ethanol on Corn Prices**

To measure how expansion of the ethanol industry has impacted corn prices, we rerun the calibrated model, freezing ethanol production at 2004 levels. A comparison of results from this “2004 ethanol” scenario with the no-subsidy results and with actual prices and quantities provides separate estimates of the impact on corn prices from subsidies and from market forces. Because the 2004 ethanol scenario imposes a much larger change on the historical corn market than the no-subsidy scenario, the results from this scenario should be viewed with some caution. Keeping this caveat in mind, Figure 6 shows the results.

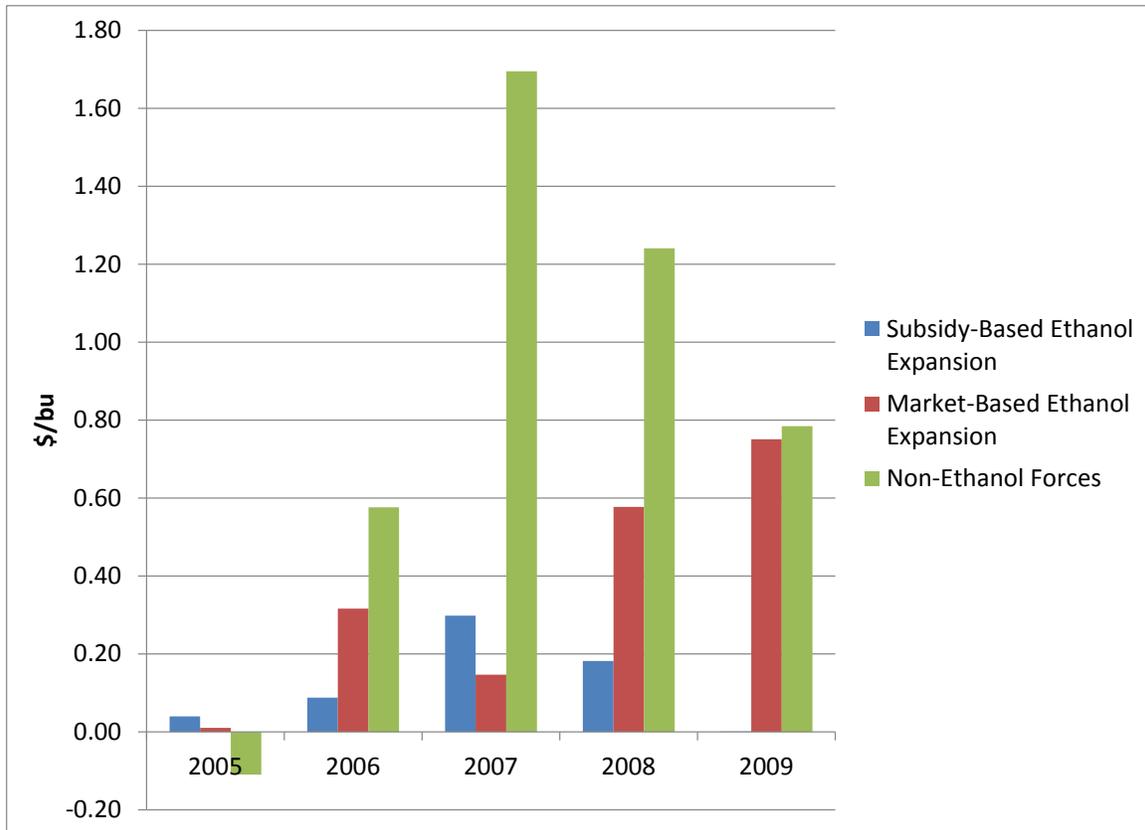
The general pattern of corn prices would have been the same as in the historical period without ethanol subsidies or without expansion of ethanol, rising from 2005 to 2007 and then declining to 2009. Corn prices would have still risen dramatically in 2007, to \$3.75 per bushel. Corn prices also would have been above levels that trigger farm bill subsidies, even in 2009. Had ethanol production been capped at 2004 levels, the model indicates that we would not today be in an era of \$2.00 corn. The reason is that relatively stronger crop prices for other commodities would have shifted acres out of corn and into soybeans, wheat, and cotton. These results show that most of the change in corn prices that we have seen is not due to ethanol expansion but rather is due to other forces at work.



**Figure 6. Actual and simulated corn prices**

Using 2004 corn prices of \$2.06 per bushel as a benchmark, we can calculate how much of the corn price changes since 2004 can be attributed to ethanol subsidies, to market-based expansion of ethanol, and to all other supply and demand forces at work in the corn market. Figure 7 shows this on a dollars-per-bushel basis. Figure 8 shows this on a percentage basis. Corn prices in 2007 were \$2.14 per bushel higher than they were in 2004. Of this amount, Figure 7 shows that about \$0.30 per bushel of this increase was due to ethanol expansion caused by subsidies and \$0.14 per bushel was caused by market-based expansion of ethanol. Fully \$1.69 of this increase was due to other factors. Figure 8 shows these contributions on a percentage basis whereby 100% equals the observed change in price each year relative to 2004. So, in 2007, almost 80% of the observed rise in corn prices was due to factors other than ethanol. In contrast, in 2009, ethanol expansion caused by both market factors and subsidies accounted for about half of the increase in 2009 corn prices relative to the 2004 benchmark price. Subsidy-driven expansion of ethanol contributed almost nothing to the observed price increase in 2009 relative to 2004.<sup>2</sup>

<sup>2</sup> The reason why none of the 2009 corn price increase is attributed to subsidies is that the model estimates that corn acreage would have been 2.5 million acres lower than what actually was planted, and, as shown in Figure 5, ethanol capacity would have increased sharply in 2009. This sharp increase in capacity means that ethanol production would have been lowered by only 9% relative to what actually occurred. The combination of a relatively modest decrease in ethanol production with a modest contraction in corn supply just happens to offset the effects of subsidies.



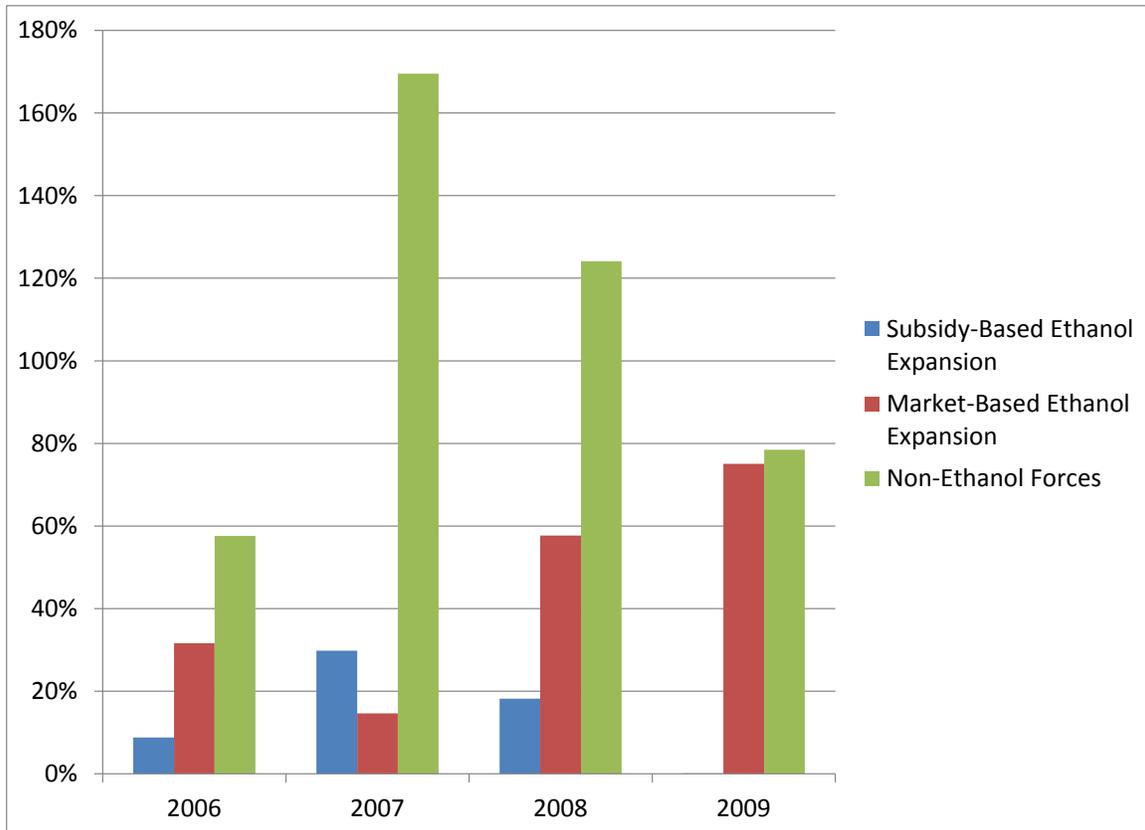
**Figure 7. Contribution of different factors to higher corn prices in dollars per bushel**

Averaging across 2006–2009, subsidies contributed an average of \$0.14 per bushel (8%) to the increase in corn prices. Market-based ethanol expansion contributed an average of \$0.45 per bushel, or about 27% of the total increase. Together, subsidies plus market-driven expansion of ethanol caused about 36% of the increase in corn prices in 2006 to 2009 relative to 2004 levels.

### Implications

The results presented here help clarify many issues in the ongoing ethanol debate. Accepting the premise that investors respond to high-return investment opportunities, the capacity of the ethanol industry would have been almost equal to what it actually was in 2009 even if the blender tax credit had been abolished on December 31, 2004, and if no mandates had been adopted. A combination of cheap corn and high-priced ethanol was the primary driver that caused investment, not subsidies. This implies that ethanol subsidies have played a minor role in determining the size of the corn ethanol industry. Thus, ethanol subsidies have contributed little to corn prices or to food price inflation.

However, expansion of ethanol certainly has contributed to higher corn prices. Just under half of the change in corn prices from 2004 to 2009 was caused by ethanol expansion. On average, expansion of ethanol from market forces increased the corn price by about \$0.45 per bushel. However, while there is no doubt that expansion of ethanol increases corn prices, it is wrong to attribute all of the increase in corn prices we have seen since 2004 or 2005 to ethanol. The pattern of corn prices that we saw from 2005 to



**Figure 8. Contribution of different factors to higher corn prices in percentages**

2009 would still have occurred even if corn ethanol production had been capped at 2004 levels.

That a strong corn ethanol industry would have emerged without subsidies or mandates runs against industry arguments that the health of the ethanol industry depends on continued subsidies and mandates. This apparent contradiction may come down to a simple case of economist naiveté. The results presented here are based on a belief that investors will invest in ethanol if it makes them money and that the petroleum industry will buy ethanol if it makes them more money than running refineries or importing gasoline. If the petroleum industry instead would have used its economic power to not buy ethanol, even if doing so made them money in both the short and the long run, then expansion of the ethanol industry would not have been as profitable as assumed here. But even naïve economists know that money can be made when \$2.00 corn can be transformed into \$5.00 worth of fuel plus some livestock feed. The pursuit of that money through investment in corn ethanol plants, whether built in the U.S. or in a corn-importing country, would have led to a sharp expansion in corn ethanol production, the share of the U.S. corn crop being converted into ethanol, and higher corn prices. It is simply the way that markets work.

*Bruce A. Babcock is a professor of economics at Iowa State University and director of CARD. Jacinto F. Fabiosa is a scientist at CARD and co-director of the Food and Agricultural Policy Research Institute at Iowa State University.*