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Perspectives on Bio-fuel Production

by Larry Martin

Introduction[i]

We pump bio-fuels into our cars, they have an effect on the price of the food on our tables, and their production takes up a sizable proportion of industry. Yet in North America and Europe, it is unlikely the bio-fuel industry would exist without government encouragement. Governments mandate that a minimum portion of fuel must be produced from non-traditional sources, then subsidize their use and protect the market with import tariffs. The mandates for ethanol are currently at least 10 percent of gasoline production in the United States and 5 percent in Canada.

Bio-fuels include ethanol and bio-diesel. In North America, ethanol is mainly produced from corn, with a small amount produced from wheat. It is also made from sugar in countries such as Brazil. Sugar is far more energy efficient than the starch in grains. Bio-diesel is commonly made from rapeseed oil in Europe and from recycled oils in North America.

Most of the growth in North American biofuels has occurred since 2005 following the establishment of product mandates, subsidies, and rising energy prices. In the most recent crop year, over 40 percent of the historically second-largest US corn crop was used for ethanol production. Canada uses roughly 30 percent of its corn production and 4 percent of its wheat to produce ethanol, although this is complicated by the fact that Canada tends to be a net importer of corn.

In recent years, roughly 45 percent of world rapeseed[ii] production was used to produce bio-diesel, mainly in the European Union.

Using grain to produce biofuels continues to be controversial, especially after this summer's drought in the North American corn belt. This paper is provided as a background on a number of issues surrounding the production and use of bio-fuels in North America, including energy and environmental efficiency, the limits to bio-fuel's energy contribution, its effect on food prices, and a proposed alternative source of ethanol.

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Energy and Environmental Efficiency

There is considerable debate about whether using grain to produce ethanol is energy efficient and whether it has a net positive impact on the environment. For instance, while process improvements have clearly improved the input – output ratios in North American production processes, cane sugar contains far more energy and is far more energy efficient than corn in producing ethanol (the energy produced per unit of energy used is higher for sugar cane). Hence the argument is, why subsidize an inefficient feedstock? Additionally, there is argument about the energy efficiency of the entire corn ethanol supply chain – what is the energy efficiency of not just the production of ethanol, but also the efficiency of producing the corn and moving it to the ethanol plant? Some contend that the entire process must be considered, especially since corn uses more energy than some other crops in its production. Similarly, supporters of ethanol claim that it is good for the environment because it has lower greenhouse gas (GHG) emissions than gasoline. Detractors argue that much of this advantage is lost because ethanol has less energy and, therefore, is less efficient in engines. Moreover, as with energy, the debate continues about the environmental impacts of the entire supply chain, starting with the fact that the basic equation for ethanol production is that one unit of corn yields one-third unit of ethanol, one-third unit of distillers dried grains (DDGs), and one-third unit of CO_2.

Limits to Energy Contribution

Forty percent of the 13 billion bushel US corn crop was used to produce about 10 percent of the nation's gasoline requirements and none of its non-gasoline fuel requirements. At the same time, the world is experiencing explosive demand for meat and other protein products for which corn is a major feed source. This means the livestock industry (more below on this subject) will likely be able to compete for corn more effectively in the future than it has in the recent past.

This may be manifested by more domestic demand for livestock feed in North America or by more import demand. This is particularly so for China, which appears to want to control consumer prices of pork, because of its importance in domestic consumption and in China’s inflation index. Until 2010, China did not import corn for feed. In 2011, it imported several million tons of corn as well as several million tons of pork. Thus far in 2012, it has already surpassed its previous year’s imports of corn, including over 1 million tons purchased at the end of April and nearly another million to date in May.

At the same time as livestock demand for corn is increasing rapidly, corn acreage is expanding to the point of raising concern about improper crop rotation having a negative impact on yield growth. It must also be stated, however, that plant breeders are working feverishly to find varieties of corn that will provide breakthrough yields.

Finally, the United States has materially reduced its subsidies to use ethanol in gasoline production as part of its attempt to regain fiscal prudence.

The implication is that it will be increasingly difficult for grain ethanol to supply a substantial portion of US energy requirements. The subsidies are less attractive, the industry will have more trouble competing for corn, and it is possible that corn production will not continue to grow, at least not at the rate it has over the past few years. Fundamentally, this means that it is unlikely that grain-based fuel can ever be a significant contributor to easing US (and Canadian) energy scarcity. Hence, examining the cost-benefit ratio becomes extremely important.

The Food versus Fuel Debate – Effects On Food Prices

The foregoing point leads directly to the debate about the efficacy of using "food" – in this case, corn – for energy. In some ways this is a rather weak argument that has come to have moral overtones. Had the process for converting corn into ethanol been discovered 100 years ago and if it had been economically feasible, there would be no debate. The issue stems from these facts: The process is relatively new, grain stocks in the world are relatively low, and, notably, there are subsidies and mandates involved.

Several economic studies attempted to quantify the effects of subsidized ethanol production on food prices. Their results vary from almost none to quite substantial. In this writer's opinion, they shed little light on the subject. The effects are too complex and involve too many lags to be measured in an econometric model.

Here are a few facts and observations that may put the food price argument into some perspective. Grain used directly in livestock feed and directly in human consumption and other industrial production in 2011/2012 increased about 15-20 percent from 1998/99. Grain used for ethanol rose about 85 percent during the same period. Add corn used in ethanol production to the amount used for human consumption and industrial production, and the total category increased by 40 percent from 98/99 to 11/12.

On the surface this appears to imply a substantial impact, at least on grain prices.

Now we'll add some perspective and complexity. In 1998/99, there was relatively small ethanol production. So, the percentage increase is a little dramatic using that year as a base. Still, ethanol is about half of all industrial (non-livestock feed) production. Pulling that much corn out of the system had to increase prices at the farm level, which eventually feeds through to higher retail food prices – and it's not just for corn-based products. Corn competes with all other crops and forage for land. Increasing corn prices raises the opportunity cost for other uses of land. The effect spreads across the agricultural sector. Corn is also the major source of energy in livestock rations and represents the largest part of the cost of producing poultry and pork; less so but still substantial for beef. Eventually, increased costs are passed on in higher livestock prices.

Before addressing the livestock pricing issue, another complicating factor needs to be added. About a third of the output from the ethanol production process is dried distillers grains (DDGs). DDGs are fed to livestock. They have more protein and less energy content than corn, but more energy and less protein than soybean meal. They are substitutes for both but not perfect substitutes for either. This means that one-third of the corn used in ethanol production comes back into the livestock feed system as DDGs. Therefore, the actual amount of grain used for livestock feed rose more than the 15 percent discussed above.

Understanding the price effect of ethanol is still further complicated by both the fact that DDGs are substitutes for corn and soybean meal, and by the fact that different livestock species have different limitations on how much DDGs can be included in their diets. Furthermore, those limitations have been reduced over time with experience and with improvements in the DDG product. There is no general agreement on the extent of the limitations.

In summary:

- Mandated and subsidized ethanol production materially increases the demand for corn.
- Corn production rose in response to the demand, thereby bidding land away from other products.

- Looking forward, there is some evidence that corn yields are plateauing, though that is not a foregone conclusion.
- Roughly a third of the corn used for ethanol comes back into the livestock feeding system as distillers dried grains.

Putting all of this together, the substantial increase in demand for grain resulting from the ethanol program clearly resulted in increased grain prices. In turn, this affected food prices. At the same time, its effect was muted by the fact that one-third of the corn comes back into the feed system as DDGs.

This is the price effect that the economic studies tried to capture. However, the effect is further complicated by the lags in the system – and the additional complexities in the lags. What does this mean? In 2008, the price increase for grain was so dramatic that the cost of feed alone was higher than the revenue a hog or beef animal generated. The complexity is that there were several other factors at play.

But, focusing on the feed issue, how long does it take for this kind of increase in feed price to manifest as an increase in pork or beef prices to consumers? First, producers try to reduce their costs. If that doesn't work, the next step is to start liquidating breeding herds, either to reduce losses or because farms fail. This may take from weeks to months. Liquidating breeding herds, especially in beef, has an immediate perverse impact: It increases supply and drives down livestock prices even further. Liquidation means that more heifers and mature cows (gilts and sows in the case of pigs) come to market. This increases the supply of beef and drives prices down farther.

Eventually, farms go out of hog/beef production and into something else and the breeding herd is smaller. From 2007 to the beginning of 2012, the Canadian hog breeding herd fell by about 20 percent and the beef herd by over 10 percent. This gives a smaller calf (pig) crop and, after the calves have enough time to grow to market weight, the supply of beef finally falls and prices rise. In other words, the livestock industry lost money in 2007/8, in part because of the rapid rise in grain prices, leading to pork and beef prices in 2011/12 that have been 50-100 percent higher than they were in 2008.

Bottom line, any economic analysis that does not take into account the lags cannot possibly measure the effect of ethanol on food prices. Even if the lags are accounted for, the plethora of other factors affecting food prices makes it extremely difficult, if not impossible, to sort out one from the others.

Cellulosic Ethanol

Cellulosic ethanol is the idea of making fuel ethanol from high fibre grasses instead of corn. The argument in its favour is that cellulosic would not require a food grain, and high fibre grasses (such as switch grass) can be grown on marginal land. Therefore, cellulosic ethanol would decrease the apparent food/fuel conflict.

The technology for making cellulosic ethanol is said to be 3-5 years away from commercial feasibility. In this writer's experience, it has been 3-5 years away for the past 20 years! So, the jury is out on whether it will work.

The technology likely has long-term implications that raise additional questions. Fundamentally, the issue is the energy efficiency of conversion. Converting the starch in corn to alcohol is much less efficient that converting

the sugar in sugar cane. Converting the fibre in grass is even less so. As improvements in the process are found, many questions will arise:

- The energy yield will be low compared to other feed stocks. How much acreage of grass will be required to produce significant supplies of energy?
- At the margin, will it really be confined to marginal land, or will it compete with food crops for superior land?
- Grasses are high in volume and low in energy density. How much energy will be required to dry or compress it, ship it to plants, or collect and disseminate the product? Will there be true system energy efficiency?
- If all of the plant is removed from the land and no vegetative material is put back, what will be the effect on soil fertility? At least with corn, the stalks, leaves and husks return to the soil as organic matter as well as manure, where the corn is fed to livestock.

These and other questions will arise as cellulosic goes forward.

Conclusion

Over 40 percent of US corn and over 30 percent of Ontario corn are currently used to produce bio-fuel. Because of the magnitude, bio-fuel production has directly increased grain prices and indirectly increased food prices. The impact is tempered by the fact that approximately one-third of the corn used in ethanol production comes back into the food system as distillers dried grains, which are used as ingredients in livestock feeds. The other two-thirds are ethanol and carbon dioxide.

Measures of the impacts are varied. Econometric attempts to measure the impact are unlikely to accurately do so because the ultimate price impacts have long lags due to the impacts on livestock production. In addition, it is unfeasible to sort out the host of other factors that affect food prices. Alternatives to grain are controversial, and not yet commercially viable. The bio-fuel industry in North America is created by government policy that mandates its use in gasoline, provided subsidies for its use, and protects it from lower priced imports. The net effects of increasing bio-fuel production, whether potentially positive or negative in terms of GHG emissions, efficiency, and food prices, are varied and too complex to tease apart and make definitive conclusions. The other effect is that a large amount of public money has been spent to create an industry that at best can contribute marginally to energy supply while increasing the cost of food. The efficiency and long-term sustainability of this set of policy instruments need to be questioned.

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[i] This paper is based on comments by the author at the Macdonald-Laurier Institute's Moving Canada Forward conference, held in Toronto on March 27, 2012.

[ii] Rapeseed was changed to remove erucic acid in Canada and its name was changed to canola. International data agencies continue to refer to the generic plant as "rapeseed."

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