Analyzing the economic factors in comparing alternative sourcing for aviation fuel

William H. Meyers and Seth Meyer

The analytical approach outlined here follows closely the methods that have been developed and successfully applied at FAPRI-MU for analyzing biofuel markets for the motor fuel industry. Underlying these methods is the simple principle that feedstocks will be produced and processed into biofuel based on expected profitability. Profit maximizing agents are assumed and the market, policy and technical factors are explicitly incorporated so that they are transparent and can be easily adjusted whenever better information is available. These methods will be elaborated as two subcomponents of an analytical system. The first will focus on fuel processing, using ethanol as the example, and delivery and the second on the production and delivery of the alternative feedstocks. In each case, net returns of the alternative economic activities are the key driving variables.

In the FAPRI-MU model, the US supply of ethanol is composed of beginning stocks, net imports and production. Ethanol production is separated into that derived from dry and wet mills (FAPRI-UMC Report #17-07) for ethanol produced from corn. Since most of the expansion of ethanol production is occurring with dry mills, the model description presented will focus on this area. Ethanol plant costs and returns are based upon USDA estimates. Dry-mill net returns (over operating costs) per bushel, denoted NRT, are calculated as the wholesale ethanol price, denoted WETHP, multiplied by the number of gallons of ethanol per bushel, denoted ETYLD; plus the distillers' dried grains with solubles (DDGS) price, denoted DDGP, multiplied by the number of pounds of DDGS's per bushel, denoted DGYLD; minus the maize price, denoted CORNP; minus the natural gas cost, denoted NATP; minus the other costs of conversion, denoted OVC (equation 1).

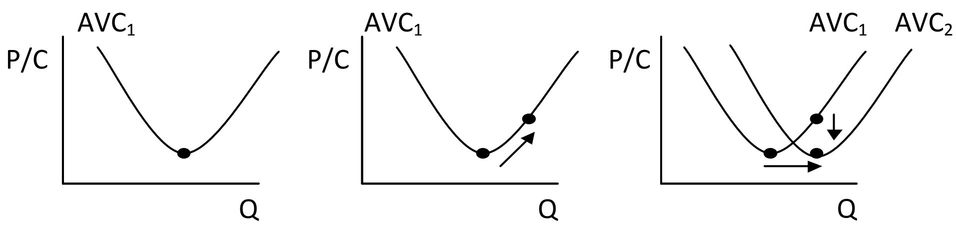
$$NRTt = WETHPt*ETYLDt+DDGPt*DGYLDt/2000 - CORNPt – NATPt - OVCt \quad (1)$$

Dry mill ethanol production, denoted PROD in equation 4, is not directly determined, but rather as the product of available productive capacity, denoted CAP in equation 2, and capacity utilization rates, denoted CAPUTL in equation 3. This structure is used because plant construction time exceeds one year (period) and once the plant is built, its useful life is expected to be at least ten years. Given the multi-period nature of investment in biofuels production facilities, CAP is estimated as a function of historical net returns with a modest impact of returns from the current year. The net returns in the capacity equations include and additional cost for capital expenditures. This is part of the long run decision making when investing in new facilities. The cost of capital for second generation biofuels may be substantial. The current year net returns are included in the specification with a very low elasticity to reflect the limited ability to accelerate the completion of plants already under construction under higher ethanol returns. There is a greater response in capacity to net returns in previous periods reflecting the period of investment decision and an average 18 month construction time for new facilities. Responsiveness peaks in period t-2. The lagged dependent variable reflects the long term nature of the capacity investment stabilizing capacity shifts from year to year (i.e. once a plant is built, the capacity is available for its useful life). The capacity in year t-10 is included to capture the retirement of older facilities but plays a small role given the relative youth of the industry as a whole. Even though capacity exists, it is possible that it may not be fully utilized depending upon the plats ability to cover its variable cost of production. Capacity utilization, denoted CAPUTL, is only a function of current period net returns (see equation 3).

$$CAP_t = f(NRT_t, NRT_{t-1}, NRT_{t-2}, NRT_{t-3}, NRT_{t-4}, CAP_{t-1}, CAP_{t-10}). \quad (2)$$
$$CAPUTL_t = f(NRT_t). \quad (3)$$
$$PROD_t = CAP_t \times CAPUTL_t \quad (4)$$

Capacity utilization rates are synthetically specified in a logistic form, bounding utilization rates between 0 percent and 100 percent and varying the responsiveness to changes in price depending on current utilization rates. By example, as shown in figure 1, a sustained increase in ethanol prices would increase utilization rates in the current period, but in subsequent periods additional capacity would be built and utilization rates would return to their ‘natural’ rate. Additional production of ethanol from other grains besides maize and cellulosic based ethanol are included in production totals.

Figure 1: Capacity and Utilization Behavior



Following this approach and specified in terms of biofuel units, the analytical system for aviation biofuel would include in the simplest form:

1. Processing capacity=f(past net returns, past capacity), where
   Net returns per gal=fuel price + coproducts value – price delivered feedstock*feedstock per gal – other cost per gal – *capital recovery* + *subsidy*
2. Capacity utilization=f(current net returns), where
   Net returns per gal=fuel price + coproducts value – price delivered feedstock*feedstock per gal – other cost per gal + *subsidy*
3. Fuel production=capacity*capacity utilization

If there were any processing subsidy or other government support for aviation fuel processing, it would need to be added to net returns. This does not exist in ethanol systems, since the tax credit goes to blenders and is then passed through to processors in the ethanol price. Similarly, the ethanol price offered at the plant reflects the cost of distribution to blenders. Distribution costs of the aviation biofuel also need to be considered as either imbedded in the fuel price at the plant or added explicitly to derive the price at the blending site. This will depend on locations of aviation biofuel plants and blending facilities, which will are likely to be different from existing motor fuel systems.

Analytical systems for production and delivery of the alternative feedstocks follows the well established methods used by FAPRI-MU for modeling competition for land among competing crops. So any feedstock produced on agricultural land would need to be competitive with the best existing land use alternative. This land use decision model is based on *expected* net returns, where net returns in its simplest form is:

1. E(Net returns per acre) = E(farm price per ton*tons per acre – production cost per acre)

2. Plant price = farm price + cost to plant (transport, storage, preprocessing)

3. Cost to plant = f(energy, capital, other costs)

Most current crops have one or more forms of government support which are all explicitly included in these net returns formula, so that any time programs change the value of these supports can be precisely reflected in the net returns formulations. If the aviation fuel feedstocks receive any form of government support, it would also need to be included here. Likewise, in a case like corn stover, the added value of the feedstock and the added cost of harvest as well as any land depletion value caused by removal of the biomass from the soil would need to be reflected in this calculation. The net returns value in any year needs to reflect as closely as possible the agent's full information set.

While the farm to processor margins are well established and known for existing crops, the "cost to plant" for new crops or even for a new coproduct such as corn stover needs to be estimated with the best available information until some actual market information is available. The components of this calculation are reflected in 2 and 3 above.

A question that arises is how price, yield and cost risks would be managed for new feedstock crops. Current crops have a wide variety of market and government risk management tools at their disposal that may or may not be available for new crops. Contracting is the most likely tool to be used for such specialized products, so the farmer will also be comparing a contract sale to whatever his or her normal marketing methods are. Many farmers have some experience with contracting, so evidence from how a farmer would compare a contract sale to alternative marketing practices may also enter into the land use decision.

In summary, methods that have been used in analyzing the biofuel industry for motor fuels can be adapted to analyze aviation biofuels. Important differences are that feedstock supplies may be in different locations and will involve newly developed collection, storage, preprocessing and transport systems, so the information requirements for this analysis are very challenging and would require substantial review and sensitivity testing. Additional questions are whether the aviation biofuel systems would be completely separate from current biofuel systems, if any current biofuel policies would apply or not, and whether sourcing would include imports or be limited to domestic sources. The analysis is fairly straightforward, but the information requirements are even more demanding then when we designed analytical systems for current biofuel markets.

Reference

Kruse, John, Patrick Westhoff, Seth Meyer and Wyatt Thompson. "Economic Impacts of Not Extending Biofuels Subsidies", FAPRI-UMC Report #17-07, May 2007
http://www.fapri.missouri.edu/outreach/publications/2007/FAPRI_UMC_Report_17_07.pdf