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U.S. Ethanol Policy: Is It the Best Energy Alternative?

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The Issue

U.S. ethanol policy has several drivers. Among these are increasing the incomes of U.S. corn farmers, enhancing the environment, providing a source of sustainable energy, and reducing dependence on foreign oil. Each of these has its own advocates and critics. While it is true that ethanol production can enhance the incomes of corn farmers, some ask who benefits more from the public subsidy of ethanol production – farmers or processors. Some question whether ethanol always delivers a clean air benefit and whether it provides a source of sustainable energy while reducing dependence on foreign oil. The large public subsidy provided for ethanol production is yet another issue. While all of the above considerations relate to ethanol policy, this article focuses primarily on energy-related issues.

The context for ethanol policy is U.S. energy policy, which is almost exclusively supply driven. Consistent with this thrust, the current target is to increase annual ethanol production from 3 billion to 5 billion gallons over the next several years. At the direct subsidy level of $US0.52 per gallon of ethanol produced, this level of production will result in a public expenditure of US$2.6 billion. The question is, what other options might provide better energy alternatives on the basis of cost and other considerations?

Implications and Conclusions

Ethanol is a minor component of the supply-oriented U.S. energy policy. It is reasonable to ask whether we would perceive the same pressing need to produce ethanol for energy supply reasons if U.S. energy policy were more diverse. Would policy makers consider options like demand reduction? Would they view energy use in terms of the services provided rather than in terms of the form, time and place constraints associated with a particular energy source? Alternative policy options might be undertaken, and analysis of these alternatives is worthwhile. Highly subsidized ethanol production does not make a major contribution to reducing liquid petroleum imports to the United States. And ethanol production has evolved so that it requires what is now another critical strategic fuel, natural gas. The issue is not whether ethanol production is a net calorie gainer or loser; rather, it is whether ethanol reduces strategic dependence and provides a needed form of fuel or energy service at lower opportunity cost when compared with demand reduction or other means of providing an energy service. Finally, the subsidy for ethanol production might be redesigned to mitigate the boom-bust nature of this capital-based processing industry and make full costs and subsidies more transparent.

Background

A set of important relationships exists between the production process and the economics of ethanol. An excellent source of information about these relationships is Tiffany and Eidman (2003). The cost of the corn feedstock is the major driver in the cost of ethanol production. The "catch 22" of ethanol production is that farmers desire higher corn prices and thus promote ethanol production. The desired higher corn prices make ethanol more expensive to produce, requiring either high petroleum prices or increased subsidies to make ethanol profitable. Table 1 illustrates various ethanol price and corn break-even costs for a 40 million gallon per year dry-milling plant, typical of many being built in the United States today.

Table 1 Break-even Corn Costs and Ethanol Prices

Corn cost (US$/bu)	**Ethanol price** (US$/gal)
2.43	1.15
3.00	1.42
3.88	1.85

Source: Tiffany and Eidman, 2003

Thus, if corn cost $US2.43, ethanol would have to sell for at least $US1.15 for the plant to break even. An ethanol price of $US1.15 was not uncommon in 2002, and corn costs were below $US2.43. In early 2004, corn cost as much as $US3.00. However, the ethanol price, which had been near the break-even point of $US1.42, rose to above $US1.85. In this example, with corn at $US3.00 and with ethanol selling at $US1.85, the profit level on ethanol is $US0.43 per gallon.

Energy costs involved in producing ethanol are not insubstantial. The fuel most commonly used is natural gas. To illustrate of the relative impacts of changes in the costs of natural gas and corn, an increase in the cost of natural gas from $US4.50 to $US6.50 per MM BTUs would have to be compensated for by a decrease in the cost of corn from $US2.43 to $US2.24 per bushel for the plant to achieve the same break-even point. Continued high natural gas costs will put pressure on ethanol profitability.

Ethanol prices have tended to follow gasoline prices – ethanol being seen as a gasoline substitute. When ethanol was initially viewed as an oxygenate, its price began to reflect its substitution for other oxygenates. Today the substitution is for MTBE (methyl tertiary butyl ether), but the price tracking still is closely related to basic gasoline prices. During times of relatively stable petroleum prices, high corn prices would normally result in reduced margins for ethanol production. Figure 1 presents the results of a profitability index developed for ethanol using prices for unleaded gasoline, corn and natural gas. This index is based on the production assumptions that one bushel of corn and 165,000 BTUs of natural gas will produce 2.7 gallons of ethanol and 17 pounds of dry distillers' grain (Paulson et al., 2004).

For most of the period, from the 1990 index levels to 2004, the index of ethanol gross margins is below the baseline of July 1990. When corn prices moved down and gasoline prices moved up, the ethanol gross margin index moved up. Late 1990 is a good example of this and July 2000 is another. In July 1996 the index went strongly negative because of very high corn prices and gasoline prices that were near the baseline. The critical question for 2004 to 2006 and beyond is whether corn prices are likely to moderate and petroleum prices stay relatively high. If so, the information in table 1 would postulate a large ethanol gross margin – much larger than that projected in figure 1. Thus, the coming several years may be very profitable for ethanol production. This scenario raises two related questions: What is the appropriate level of subsidy? How should the subsidy level be determined? The current subsidy of $US0.52 per gallon of ethanol is scheduled to be reduced to $US0.51 in 2005.

One of the most contentious issues with respect to ethanol production is the caloric accounting argument. Does ethanol production use more energy than that embodied in the final product? i.e., is ethanol a net energy gainer or loser? This disagreement started in the 1970s and has continued unabated over the intervening decades. The most recent exchange involves David Pimentel, one of the original protagonists, and several authors from the USDA Office of Energy Policy and New Uses (Pimentel, 2003; Shapouri, Duffield and Wang, 2002). The argument hinges on estimates of calories required by various processes and embodied in various inputs and also upon where one draws the calorie accounting envelope around ethanol production. Both the envelope and the

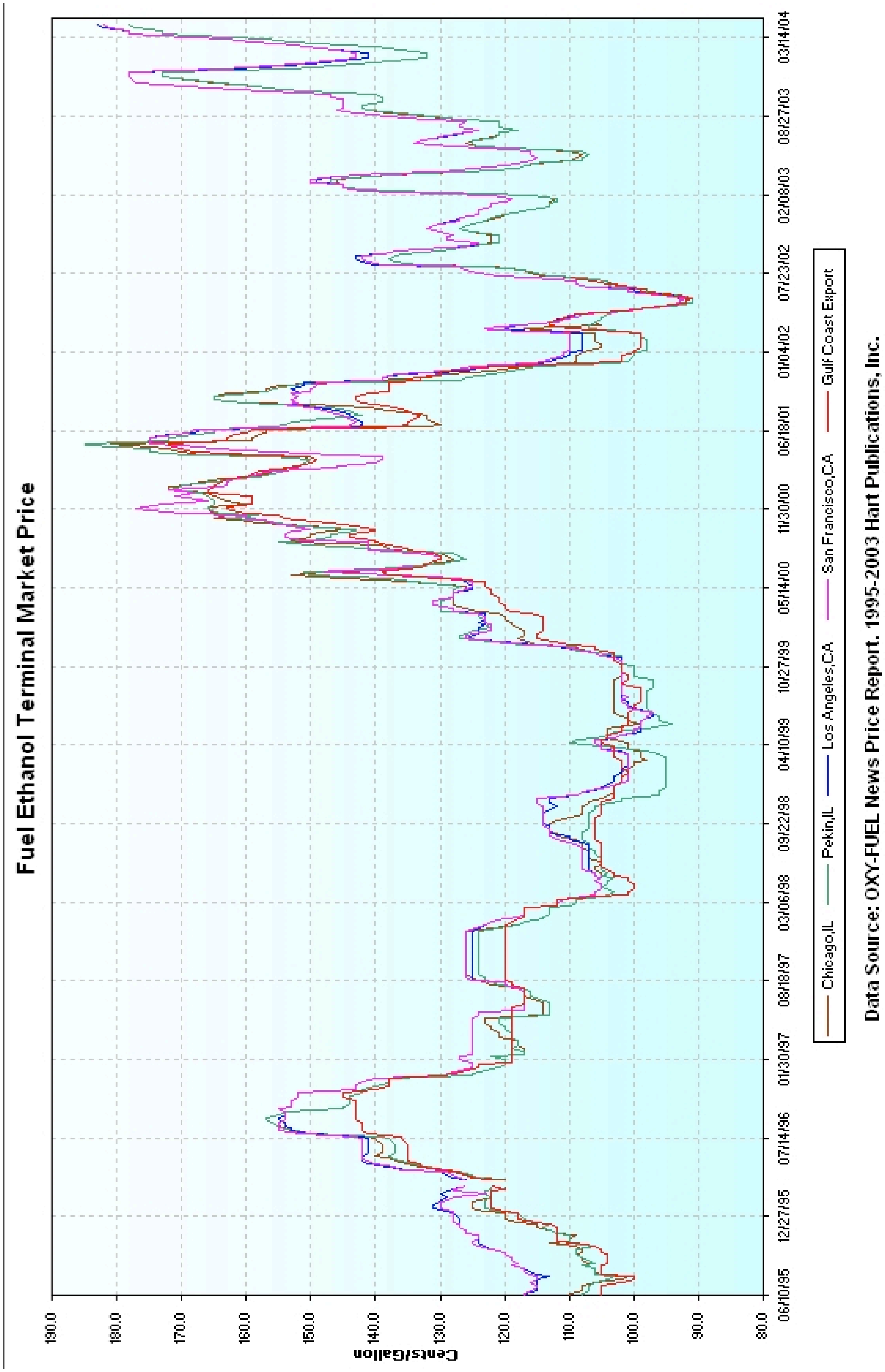

Figure 1 Ethanol gross margins index with coincident corn and gasoline price indices
Source: Paulson et al.. 2004

calories assigned to inputs and processes have been modified over time as technology and assumptions have changed. An early set of approaches to this accountancy illustrating these differences was that of Pimentel (1976) and Doering (1977). The first of these two works was a static example based on an accounting approach, and the second was a simulation approach. Not only did the process assumptions and the envelopes employed by these two approaches differ, but the determinants of productivity of inputs differed as well. In a sense it was an apples-and-oranges comparison because assumptions were so different, and this mismatch continues today.

The critical question is whether the calories battle really matters! The judgment here is that it does not matter for making policy. This judgment hinges on the policy objective for producing ethanol. If one is producing ethanol to add sustainable energy from biomass to our energy stock, then a net energy gain may matter. If one is producing ethanol because we are short of liquid fuels, it does not matter. Assuming one used abundant coal and natural gas to make machinery, produce fertilizer and power ethanol plants, we would be using solid and gas forms of energy that we had in abundance to produce a liquid fuel that was in short supply. What has changed this initially logical conversion of solids and gas to liquids is the fact that the North American continent is no longer self-sufficient in natural gas. In addition, we have generally been firing ethanol plants not with coal, but with natural gas. Natural gas is a major feedstock for the total ethanol production system. Increases in ethanol production will require increased imports of natural gas at the margin. Aside from strategic supply concerns, one can carry this argument on to logical (or illogical) conclusions with another trade-off and claim that increased use of corn for ethanol production lowers corn exports that would otherwise earn foreign exchange to pay for imported liquid and gas fuels. The test is which of these arguments really matters for policy.

Natural gas is important to U.S. energy policy and strategic concerns because natural gas use since the oil embargo of the 1970s has shifted towards uses where its unique attributes are less important. Initially, the bulk of our natural gas was used for special heating applications (like food drying and heat-treating metals), home heating and cooking, commercial space heating and chemical feedstocks. One change at the time of the OPEC oil embargo was a shift in industry to dual-fired boiler capacity. From the embargo on, industrial firms designed process heating systems so that they could switch between oil and natural gas. Initially this was done for reliability, but ultimately fuels were switched on the basis of which fuel was least expensive. For a period after the OPEC oil embargo, natural gas was scarce and its use in electricity generation was not allowed. However, the combination of an ensuing glut of natural gas, a return to long-term supply contracts, the compelling economics of utility deregulation and the environmental advantages of using natural gas over coal led to increasing amounts of natural gas being used for electricity generation. Both industrial and especially electric power generation uses of natural gas have surged since the high price/low availability period of the mid-1980s while residential use is about the same as it was in the 1970s (National Petroleum Council, 2003).

What does this mean for ethanol? If ethanol production depends on natural gas (for process heat and for fertilizer) and natural gas is increasingly imported, then ethanol may provide a scarce liquid fuel, but its strategic advantage is moderated by the fact that strategic natural gas now is required for ethanol production. Yet, it is the strategic advantage of reducing import dependence that many see as a critical reason for ethanol production.

One alternative that might obviate these issues would be substantial investment in renewable energy, especially liquids from biomass. A recent inclusive compendium of the potential opportunities claims that nearly 50 percent of U.S. energy needs could be met with renewable sources (Pimentel et al., 2002). The applicable question here is whether ethanol can be produced economically with biomass feedstock rather than with corn. While this technology has had promise since the 1970s, it has not yet lived up to expectations. Conceivably such feedstocks could allow greater production of ethanol at lower calorie and dollar cost.

The more basic question for ethanol policy hinges on the supply orientation of U.S. energy policy. Are the opportunity costs for meeting energy needs more favourable elsewhere? There are two aspects to consider in looking for other ways to meet energy needs. One is utilizing substitute energy sources to do the same work or provide the same service as a scarce energy source. The other is reducing demand. Both of these approaches were seriously developed in the period immediately following the OPEC oil embargo. This is illustrated in table 2, from a U.S. Department of Transportation study on future paths for transportation fuels and systems under different scenarios of fuel and alternative system development. Note that the metric here is "transportation petroleum equivalents".

Table 2 1981 Resource Cost of Transportation Petroleum Equivalents

Area of development	**Cost** ($US/bbl)
Shale oil	32.21–35.73
Coal liquids	40.69–46.08
Auto fuel economy	25.37–38.23
Biomass	59.00–52.10
Railroad electrification	22.82–24.88

Source: Whitford et al., 1981

This study was done some years ago and the absolute numbers are certainly not necessarily accurate today. However, the relative numbers do have meaning and illustrate a broader scope of policy options that one might consider – especially on an opportunity cost basis. The critical points of comparison include the fact that liquids from biomass are relatively expensive. Reducing auto fuel demand through increasing auto fuel economy is one of the less expensive options, as it still is today (Congressional Budget Office, 2003). Railroad electrification is the least expensive option for "creating" liquid fuel, that is, for providing the same energy service from a very different energy source, in this case solid coal instead of liquid petroleum. The assumption here was that we could increase electricity production from coal in an environmentally acceptable way at a relative service cost lower than other alternatives; in addition, the petroleum equivalent generated is modest.

Critical to this approach is the notion of energy services that was promoted by Roger Sant (1979). This approach breaks the form, time and place constraints. What are desired in the example above are transportation services. Both today and prior to the OPEC embargo, transportation is viewed as tied to the availability of liquid fuels. Investment and technology are bounded by the liquid fuel–form supply paradigm. We broke out of that in the late 1970s and early 1980s because it was evident that such supply might not always be available. We then returned to a supply focus when petroleum (and natural gas) prices declined and supply seemed assured.

Assessment

Ethanol is still a component of the supply paradigm. The United States will probably increase ethanol production to 5 billion gallons a year over the next several years and continue to pay a subsidy to do so. If ethanol processing is not powered by coal and fertilizer is not freed from dependence on natural gas, it is going to be increasingly hard to make the case that we are producing a scarce liquid fuel out of abundant or non-strategic resources. The argument that ethanol will free us from dependence upon outside sources of petroleum does not hold. When U.S. ethanol production ramps up to 5 billion gallons, ethanol will supply approximately 3.5 percent of current U.S. gasoline needs. A demand reduction approach that increased fuel efficiency standards by 3.8 miles a gallon for cars and light trucks could reduce gasoline consumption by 10 percent (Congressional Budget Office, 2003).

At some point options beyond the current focus on energy supply would appear to be compelling. However, these were only considered in the past when absolute supply restrictions were real and thought to be permanent. Ethanol policy should probably not be based on the battle of the calories. There are numerous other bases for making ethanol policy and the narrow focus of calorie balance as a national goal is outweighed by strategic and other concerns. The calorie argument also keeps us firmly within the supply paradigm.

Given that we are likely to continue producing ethanol, one question is, what should be the level of the subsidy? A suggestion would be to utilize a measure like the index of ethanol gross margins to adjust the subsidy as conditions, costs and prices change over time, preventing boom and bust situations. This concept will face objections from free market proponents. However, with the high subsidy this is not a free market good, and it would not be produced without the subsidy. A variable subsidy could have features like proposals for public utility incentive regulation. Ethanol production has public utility aspects, it is just not thought of as such.

Finally, the argument here is not that we should give up ethanol production or abandon other supply efforts, but that we must assess and embrace other options as conditions dictate.

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