Journal of Agricultural and Applied Economics, 42,3(August 2010):395–401

Should We Invest in Biofuels?

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The real advantage of receiving a Southern Agricultural Economics Association Lifetime Achievement award is the ability to make this presentation and have it published without having to deal with editors and referees. This provides a certain license of freedom to abstract outside the box without being constrained by your peers. So in this vein, consider the following myths and predictions concerning biofuels. These myths are generally consistent with the Grunwald's (2009) seven myths about alternative energy.

Myth 1. The World is Running Out of Oil, So We Must Adopt Alternatives, Such as Biofuels, Now

Considering a global oil market, while oil is constantly being consumed, the world is not running out of oil (Adelman and Watkins, 2008). The ratio of reserves divided by annual production has grown from a multiple of 29 years in 1980 to 45 years in 2008. We currently extract a smaller fraction of remaining oil reserves each year than several decades ago (Smith, 2009). Considering heavy oil, oil sands, and oil shale, our petroleum resources will last 160 years at current consumption (Aguilera et al., 2009).

The problem is as the demand and supply relations for energy tighten the volatility of energy prices will increase leading to energy price instability. An example is the run up of oil and gasoline prices in 2007–2008. The rapid economic growth of China and India tightened the demand for oil and then in late 2008 this demand relaxed with the global economic slowdown, leading to high instability in oil prices. This instability is exasperated with OPEC's (Organization of the Petroleum Exporting Countries) objective of restricting new oil production capacity, which maintains a tight demand and supply relation. We are not running out of oil, but are facing an era of increased oil-price instability. As addressed below, this current oil market suggests policies of developing a portfolio of energy-platforms to circumvent price swings.

Myth 2. The Major Negative Externalities Associated with Driving Vehicles are Greenhouse-Gas Emissions and Energy Insecurity

Partitioning marginal external costs of driving into fuel-related cost and mileage-related costs, Parry and others, in two articles, calculates the total marginal external cost in cents per gallon of gasoline (Parry and Small, 2005; Parry, Walls, and Harrington, 2007). The fuel-related costs composed of greenhouse gases and oil dependency are only \$0.18 per gallon compared with mileage-related costs composed of local air pollution, congestion, and accidents of \$2.10 (Parry, Walls, and Harrington, 2007). Local air pollution costs are only \$0.42 of total mileage related costs. Subsidizing biofuels may have some impact on fuel-related costs, but reduced fuel prices provide incentives for increased driving which aggravates the far more pervasive mileage-related costs. In fact, considering these negative externalities, the optimal ethanol subsidy probably should be a tax

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(Vedenov and Wetzstein, 2008). As addressed below, the magnitude of these externalities suggest policies for internalization.

Myth 3. Ethanol is a Substitute for Gasoline

Prior to 2005, ethanol as an oxygenate was primarily a substitute for other gasoline additives mainly MTBE (methyl tertiary butyl ether). However, liability issues with other gasoline additives and antibacksliding provisions of the 2005 Energy Bill regarding air quality essentially left fuel blenders with ethanol as the only oxygenate alternative. As a consequence, the substitutability between ethanol and other gasoline additives is now replaced by a complementary relationship between ethanol and petroleum-based gasoline. This complementary relation is further reinforced by the current blending restriction of a maximum 10% ethanol for conventional blended gasoline in conjunction with the ethanol mandates under the Renewable Fuel Standard program (Zhang, Qiu, and Wetzstein, 2010). As addressed below, considering the current relationship between ethanol and gasoline, the ethanol tax-credit policy is questionable.

Myth 4. Biofuels Cause Food Price Inflation (the food before fuel issue)

Research indicates, in the short run, yes there probably is some Granger causation between ethanol and agricultural commodity prices. However, results indicate that in the long run, there is possibly no relationship. Some investigations point to a possible recent structural shift leading to a long-run relationship. However, economic theory suggests competitive decentralized markets will restore prices to their long-run equilibrium trends after any agricultural price shocks due to increased ethanol demand or other shocks (terrorism) (Harri, Nalley, and Hudson, 2009; Harrison, 2009; Hayes et al., 2009; Zhang et al., 2009 and 2010). The recent rise and subsequent fall in food and fuel prices is probably due to the heating up and cooling off of economic activity. Global economic activity is possibly the underlying cause of both food and fuel price instability (Killan, 2009).

These empirical relations between fuel and agricultural commodity prices suggest policies should be directed toward mitigating the short-run impacts on food prices. Possible policies for consideration are: expand emergency humanitarian assistance to food-insecure areas, undertake food production programs, reduce or eliminate agricultural trade restrictions by completing the Doha Round of World Trade Organization negotiations, and create public and private grain stocks.

Myth 5. Corn Ethanol is Competitive with Sugarcane Ethanol

In general, Brazil has a comparative advantage, if not an absolute advantage, in the refining of ethanol and continues to invest and expand sugar-based ethanol with a global strategy focused on enhancing exports to Asia and Europe (Henniges and Zeddies, 2007; Lilliston, 2005; Sheldon and Roberts, 2008). The United States is increasingly trading an export in which it has a tremendous comparative advantage (corn) for a product in which it has a comparative disadvantage (ethanol) (Henniges and Zeddies, 2007). Removing the current U.S. import tariff on ethanol would allow Brazilian sugar ethanol to directly compete with U.S. corn-based ethanol. Such competition would shrink domestic production of ethanol to a regional Midwest market (Zhang et al., 2008).

Myth 6. Cellulosic Ethanol Will, Within the Next Decade, become Commercially Viable

Like US bullet trains, cellulosic ethanol will always be the technology of the future. Even with government incentives and regulations, cellulosic-based ethanol has major economic and technical hurdles to overcome before it can be competitive with corn-based ethanol (Carolan, Joshi, and Dale, 2007; Kenkel and Holcomb, 2006; Miranowski, 2007; Young, 2009). Large biorefineries are probably necessary to achieve process economies for cellulosic-based ethanol refining (Ginder, 2007). The cost to deliver a large continuous flow of biomass will depend critically upon the logistics of procuring, storing, and transporting (Carolan, Joshi, and Dale, 2007; Henderson and Akers, 2007). Logistics are coupled with high transaction costs of contracting with numerous biomass producers, market power issues, and environmental impacts (Carolan, Joshi, and Dale, 2007; Epplin et al., 2005). In contrast to grain feed stocks, there are no handling and storage systems already in place that can accommodate increased ethanol demand. These constraints are, in addition to infrastructure, issues of pricing and regulation. Some type of commodity grades and standards will be necessary to permit trading of sustainable biomass (Dam et al., 2006). Without any subsidies, cellulosic ethanol will only at best become a small niche market in isolated local areas. Cellulosic ethanol has major economic and technical hurdles to overcome before it can be competitive with corn-based ethanol (Zhang and Wetzstein, 2008).

Myth 7. Biofuel Will become a Major Vehicle Fuel

With continued mandates and subsides, it is likely at least in the short-run, that the use of biofuels will steadily grow. However, given the uncertain economic and environmental impacts of large-scale conversion of biomass crops to fuel, biomass will contribute to, but unlikely dominate, the future fuel supply (Heywood, 2006). The near future of our vehicle transportation system is in hybrid vehicles. Within a decade, plug-in hybrid electric vehicles will replace the current generation of hybrids. It is estimated that if the entire U.S. vehicle fleet is replaced with plug-in hybrids, the nation's oil consumption would decrease by 70%, completely eliminating the demand for imports (Kammen, 2006). In the long run, as the internal-combustion engine shrinks as a vehicle power source, biofuel gasoline blends may be used to fuel it.

Should We Invest in Biofuels?

Considering these myths, one may answer no to this article's title. However, the answer is not no but yes. At least in the short run, it is important that we investigate all of the potential alternative sources for energy. Similar to President Kennedy's declaration of going to the moon within the 1960s decade, over 35 years ago President Nixon made the declaration of the United States becoming energy independent by the end of 1970s. Unfortunately, in the 1970s or since, we have not adequately invested in research and discovery to at least diversify our energy supply. The world is facing major technological and economic problems of developing sustainable substitutes for our nonrenewable, economic, and environmentally risky use of petroleum. As a consequence, a Manhattan type energy program is required. We are up against a wall facing ever increasing volatile petroleum prices and petroleum's negative effects on greenhouse gas emissions and local air quality along with increasing vehicle congestion and accidents. We require parallel research and discovery avenues for all potential alternative energy-technology platforms including solar, wind, geothermal, nuclear, and yes, bioenergy (Young, 2009). No one alternative energy will be a long-run silver bullet for solving our energy price instability and negative driving externalities (Bassi, Powers, and Schoenberg, 2010). Instead, a portfolio with platforms of alternative energies will emerge from this comprehensive investment. Ahman and Nilsson (2008) state a smorgasbord of government programs are justified in developing a portfolio of vehicle fuels, which address both fuel-price instability and negative vehicle externalities. Contrary to the conventional wisdom, which subscribes to the government or the market picking one winner, a portfolio of energy-technology platforms should all be subjected to focused and concerted development efforts. These alternative platforms are complements rather than substitutes for establishing a diversified energy sector for our society (Ahman and Nilsson, 2008). Such a diversification is in society's interest and probably the preferred choice relative to just a biofuel platform as a transportation-energy alternative. Consumers generally would prefer increases in public transit or nonbiobased alternatives (Petrolia et al., 2010).

The opportunity cost of such a Manhattan program is lost funding for other research projects. In terms of biofuels, by crowding out other biotech research, there are potentially significant opportunity costs. This includes competition between developing environmentally sound genetic engineering on perennial crops versus cellulosic-based ethanol. Such funding allocations are analogous to the flypaper effect in public finance where a grant for a specific project stimulates more spending by an institution on that project than an equal increase in the general budget. This is in contradiction to the theoretical prediction that the effects should be the same (Cordes, Ebel, and Gravelle, 2005). These flypaper opportunity costs should be taken into consideration when allocating such funding (Zhang and Wetzstein, 2008).

A major portion of this portfolio should be and will be an energy-conservation platform. There is a huge potential for energy efficiency measures mitigating petroleum price instability and negative vehicle externalities (Jochem, 2006). Increasing the Corporate Average Fuel Economy (CAFÉ) standard would cost approximately a third as much as it costs to subsidize ethanol (Doering, 2006). Conservation efforts through increasing the CAFÉ standards dominate, in terms of economic efficiency, the whole fuel-ethanol subsidy program. However, these standards, through improved fuel efficiency, lowering the per-mile driving cost come at a potential increase in negative external mileage costs. Lower per-mile driving costs, leading to increased driver mileage, aggravates air quality, accidents, and congestion. Relative to a fuel tax, this is the classic advantage of a Pigouvian tax (fuel tax) versus a standard (CAFÉ).

In terms of biofuels, at least in the short run, as a complement with petroleum fuel they will play a direct role in reducing vehicle-fuel price instability (Vedenov, Duffield, and Wetzstein, 2006). However, in the long run, electricity will be an important growing platform within this portfolio and will probably dominate all the other vehicle energy sources. Again in the future, as the internal-combustion engine shrinks, biofuels will probably complement petroleum fuels in a shrinking market.

Alternative Energy Policies and Directions

Fuel Tax

The current tax credits for alternative fuels, including biofuels or alternative fueled vehicles, are far less efficient instruments than vehicle-fuel taxes. Such subsidies or credits do not exploit the entire range of fuel conserving options, which include reduced use and improved fuel economy of conventional vehicles (Parry, Walls, and Harrington, 2007). Although not revenue neutral, rebating such fuel taxes through possible lower income and payroll taxes will tend to mitigate any regressive nature of a fuel tax. However, as vehicle power trains migrate toward electricity, such taxes will be less effective in mitigating mileage related vehicle externalities. Alternative taxation incentives, including a vehicle-mileage tax, may offer a more efficient mechanism design for internalizing external costs. Such electronic toll collection mechanisms do raise privacy concerns, even with mechanisms designed to avoid a central collection of private travel information (Parry, Walls, and Harrington, 2007). Analogous to a mileage tax is mileage-based insurance, currently available in California and Texas with consideration in a dozen or so other states. In particular, these mileage-based taxation schemes will provide incentives to shift our transportation network toward public transit.

Economists' Role

An emerging alternative energy source must fit into the current fuel system and maintain reliability at competitive cost. Policymakers should be willing to commit resources for developing improved understanding of alternative policy-pathway consequences, just as they currently have committed to developing technology pathways (De La Torre Ugarte, 2005; Michaelis, 1995; Tyner and Taheripour, 2007). With these resources, economics will reveal the efficient portfolio of platforms yielding a reliable and cost-effective integration of our energy demands and supplies. A commitment of resources to economic analysis will yield more precise estimates on the logistics of producing, harvesting, storing, transporting, and providing a continuous flow of feedstock for biorefining. Economic analysis can then be employed to estimate its feasibility (Heywood, 2006).

Such a commitment will also aid in developing econometric assessments of biofuel policies. Past research efforts are either theoretical or simulation based which limits our ability to extract economic statistical inferences for policy analysis (Zhang and Wetzstein, 2008). With a commitment, future research can address the problems of short time series for biofuels, difficulties in isolating inferences from a single policy, difficulties in detection of causality, and extending policy analysis to environmental externalities (Gardner and Tyner, 2007; Lilliston, 2005). Furthermore, previous research is not definitive on the net environmental benefits and costs of biofuels, with limited if any knowledge of their magnitude (Gallagher et al., 2006; Kammen, 2006; Tareen, Wetzstein, and Duffield, 2000).

Improved Policy Analysis

These improvements on the theoretical and empirical tools used to address biofuel economics will improve our policy analysis. Programming models which approximate market prices and quantities when regulations constrain markets, static models replaced by dynamic models which capture the interactions between agricultural and energy markets, and models addressing the risk and uncertainty of policies and biofuel investments will be developed (Doering, 2005; Lilliston, 2005). In terms of risk and uncertainty, case studies indicate considerable ethanol and corn price instability (Tembo, Epplin, and Huhnke, 2003). This suggests future development of real options approaches with stochastic ethanol and corn prices in determining when to undertake an ethanol refinery investment.

Various research results indicate the potential of the United States to supply a major portion of its energy from biofuels (Lilliston, 2005). Such a partial equilibrium analysis is limited and can lead to a false sense of future biofuel security. Instead, future research should consider, in a general equilibrium analysis, how a biofuels platform fits into a portfolio containing other energy and energy conservation platforms (Zhang and Wetzstein, 2008).

An improved understanding is required of the international trade flows of biofuels for determining the distributional costs, benefits, and associated risk of filling a gas tank instead of a stomach (Lilliston, 2005). Economic models are required in support for establishing international cooperation in developing biofuels, such as how to transfer the Brazilian learning curve to developing countries (Runge and Senauer, 2007). Physical capital can be transferred relatively easily compared with human capital. No country has been able to launch a domestic biofuels industry without active government support, so it is important to carry out economic feasibility studies for such public support (Kojima and Johnson).

Conclusions

We are faced with a multitude of evils associated with the burning of fossil fuels for our transportation systems. These evils include greenhouse gas emissions, energy insecurity, air quality, accidents, and congestion. One can disagree about the relative magnitudes of these evils and the order of national concern, but by bundling them together, a general agreement will emerge that we have delayed too long in addressing them. Currently, we are attempting to focus on these evils in terms of developing technologies for mitigating their negative impacts on our economy and social fabric. However, new technological platforms alone are not a sufficient condition for weaning us from our addiction to fossil fuels and highway extensions. Economic platforms are also necessary for assessing the merits of these technological platforms and how they will complement each other in a new portfolio of energy and transportation diversification. Such economic platforms are not just investigating the economic feasibility of one technology platform. Instead they are an investigation of alternative energy and transportation portfolios leading toward an economic and environmental sustainable energy paradigm. Returning to biofuels, the role for economist is not being a proponent for one particular bioenergy-technology platform, but instead investigating these alternative bioenergy platforms within a portfolio of alternative energy platforms.

The market and associated government programs supporting bioenergy are extremely fluid making such an investigation of alternative bioenergy platforms challenging and exciting. This market and government program instability is causing associated volatility in input markets, such as grain markets, output markets, petroleum markets, and external nonmarkets such as water quality and greenhouse gases. Such instability makes bioenergy a very fascinating area of study for economists. If I had one wish, I would like the opportunity of being a young economist just starting to develop a scholarly program in alternative energy economics. The potential major research discoveries are there to be uncovered and with the excitement of communicating these discoveries within the classroom, among peers, and the community, it is a wonderful fulfilling professional life. Fortunately, by definition, I will not live into the long run to see my projections become invalid. We just do not know with certainty what the future has in store. You may see switchgrass planted fencepost to fencepost in the southeast.

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