

## Economic Impacts of Not Extending Biofuel Subsidies

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The exponential growth of the biofuels industry has created significant increases in feed prices to the livestock sector. In February and March of 2007, the National Cattlemen's Beef Association and the National Pork Producers called for the non-renewal of the \$0.51-per-gallon excise tax credit for ethanol as well as elimination of the \$0.54-per-gallon import tariff on ethanol. This study uses a stochastic model to analyze the impact of not extending the ethanol tax credit, the ethanol import tariff, or the \$1.00-per-gallon biodiesel tax credit on the biofuels and agricultural commodity markets. The Renewable Fuel Standard mandate requiring a minimum of ethanol use is maintained. The study finds that future growth in biofuels relies heavily on the extension of the tax credits and import tariff. Commodity prices will fall without the extension of them and make net farm income drop by an average of \$3.1 billion per year over the 2011-2016 period. This is because lower feed prices for livestock producers represent low output prices for crop farmers.

**Key words:** ethanol, biodiesel, subsidies, ethanol import tariff, stochastic simulation, model.

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### Introduction

The exponential growth of the ethanol industry has begun to draw concerns from the livestock industry as feed costs jumped nearly 30% from October 2006 to February 2007 (Warner, 2007). These concerns prompted both the National Cattlemen's Beef Association (Shinn, 2007) in February 2007, and the National Pork Producers (Warner, 2007) in March 2007 to call for non-renewal of both the excise tax credit for ethanol and the import tariff on ethanol. Other groups such as the American Petroleum Institute have argued that biofuels should compete on their own economics rather than on government subsidies (Cavaney, 2007). Biofuels already hold a prominent position in the 2007 farm bill debate. This analysis seeks to offer two contributions to the literature:

1. provide perspective on the degree of biofuels' dependence on the tax credit and tariffs, and
2. describe the impact of discontinuing the biofuel subsidies and the ethanol import tariff on commodity markets, government costs, and farm income.

### Literature Review

The explosion of the biofuels sector has occurred so quickly, and the data so sparse, that there are few relevant published journal articles on the subject. There are a number of recent working and briefing papers, but the biofuels industry has grown faster than even these papers foretold. Two papers of particular relevance to

this study were written by researchers at the Center for Agriculture and Rural Development (CARD) at Iowa State University.

In October 2006, CARD researchers Elobeid and Tokgoz (2006) evaluated two scenarios against the January 2005 baseline of the Food and Agricultural Policy Research Institute (FAPRI). However, the biofuels industry has been growing much faster than the FAPRI January 2005 baseline anticipated, resulting in much higher corn prices than FAPRI's baseline had projected. The first scenario considered the impact of removing the US import tariff of \$0.54 and the 2.5% *ad valorem* tariff on ethanol, but continuing the \$0.51 tax credit. The analysis indicated that cheaper imports from Brazil would reduce US ethanol prices, which would cause the blend price of ethanol and unleaded gasoline to fall and US total gasoline consumption to increase. In response to lower domestic ethanol prices, US ethanol production declined. The second scenario included the removal of both the ethanol tax credit and import tariff. The removal of the tax credit resulted in lower ethanol producer prices and higher prices to fuel blenders who buy ethanol, leading to lower ethanol consumption. Interestingly, US ethanol imports from Brazil continued to increase, though not as dramatically as in the first scenario.

In another article, Elobeid, Tokgoz, Hayes, Babcock, and Hart (2006) estimated a long-run demand for ethanol in order to determine the derived demand for corn as an input into this process. These authors assumed the

long-run demand for E85 is determined by the price at which the consumer can buy an equivalent amount of energy in it or conventional gasoline.

This study expands on the earlier research by developing a more detailed model of the biofuels sector that captures supply and demand relationships in greater detail and improves the relationship among fuel prices. Elements such as the federal tax credit provided public support of ethanol production. They are included in most models documented in the literature, but most published articles relate to biofuels policies in other countries. Duffield and Collins (2006) present a broader description of US ethanol policies.

### The Stochastic Biofuels Model Structure

The FAPRI stochastic model of the US agricultural sector is a non-spatial, partial equilibrium model covering markets for major grains (wheat, corn, rice, sorghum, barley, and oats), oilseed (soybeans and their derivatives, sunflower seed, canola, and peanuts), cotton, sugar, beef, pork, poultry, and dairy products. The structure of the stochastic model is a simplification of the FAPRI deterministic modeling process in that reduced form equations were used to simulate trade in the rest of the world normally represented by international country and regional models when scenarios touch on policy changes or events taking place outside the US, and aggregating domestic supply regions to a single national market. Even with these simplifications, the model still contains more than 1,000 equations representing US crop and livestock supply demand, trade, and prices as well as sector aggregates such as government expenditures on farm programs, net farm income, agricultural land values, and consumer food price indices (FAPRI, 2005). The model has also been extensively developed with the addition of equations representing ethanol and biodiesel markets.

The crops sector is modeled through behavioral equations representing crop acreage, domestic feed, food and industrial uses, stock holding, and trade. Similarly, the livestock sector is modeled through behavioral equations determined by animal numbers, meat and dairy product production, consumption, stock holding (where sizeable), and trade. Equations in the biofuels module tie into industrial demands for grains and vegetable oils, and behavioral equations determining ethanol and biodiesel production, consumption, and trade in products and blends with other motor fuels. The model solves for the set of prices that balances annual supply and demand into balance in all markets.

Of particular interest to the present study are the equations that determine the supply, demand, and price of biofuels. Since the biofuels industry is rapidly growing and very little data is available for the period of rapid expansion, many of the equations are synthetically derived by using elasticity assumptions and calibration to the recent history. The model structure for ethanol and biodiesel is very similar with the major exception that glycerin is the primary byproduct of the biodiesel market and consumer demand for biodiesel is estimated as one equation instead of being broken into segments like the ethanol demand. Since the most dominant biofuel in the US in 2007 is ethanol, the framework of this model is described in detail. Ethanol production is separated into ethanol derived from dry mills and that which is derived from wet mills. In the case of traditional *dry* mills, distillers' grains (wet and dry) are the primary byproduct of value. In the case of *wet* mills, the byproducts include corn oil, corn gluten feed, and corn gluten meal. 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 (Shapouri, 2006) estimates. Dry mill net returns per bushel (NRT) are calculated as the wholesale ethanol price (WETHP) multiplied by the number of gallons of ethanol per bushel (ETYLD); plus the distillers' dried grains (DDG) price (DDGP) multiplied by the number of pounds of DDGs per bushel (DGYLD); minus the corn price (CORNP); minus the natural gas cost (NATP); minus the other costs of conversion (OVC) (see Equation 3).

Dry mill ethanol production (PROD) in Equation 4 is not directly determined, but rather is the product of available productive capacity (CAP) in Equation 1 and capacity utilization rates (CAPUTL) in Equation 2. This structure is used because it takes about 18 months to construct an ethanol plant 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 net returns over five periods, including the current year. The current year net returns are included in the specification with a very low elasticity since the only ability to respond in the first year is to accelerate the construction schedule for plants already under construction. The net returns elasticity increases as one moves from the current to previous year's, and two years prior's net returns. This reflects the ability to show more response given a longer time period and the average 18-month construction process. The net returns elasticities are assumed to be smaller for year's t-3 and t-4 since the construction pro-

cess only takes 18 months. 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 it currently only plays a small role given the relative youth of production facilities. Even though capacity is built, it is possible that it may not be used if the plants cannot cover their variable cost of production. CAPUTL is only a function of current period net returns (see Equation 2).

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

$$CAPUTL_t = f(NRT_t) \quad (2)$$

$$NRT_t = WETHP_t * ETYLD_t + DDGP_t * DGYLD_t / 2000 - CORNP_t - NATP_t - OVC_t \quad (3)$$

$$PROD_t = CAP_t \times CAPUTL_t \quad (4)$$

CAPUTL are synthetically specified in a logistic form, bounding utilization rates between zero and 100% and varying the responsiveness to changes in price, depending on current utilization rates. Additional production of ethanol from other grains besides corn and cellulosic-based ethanol are included in production totals.

The demand portion of the ethanol model is necessarily more complicated than the supply side because it captures both the retail level (consumers) and wholesale level (blenders), and must also consider the total retail market for motor fuels. Retail ethanol demand is broken down into demand for ethanol as an additive (the 10% ethanol market [E10] less the additive market) and the 85% ethanol market (E85). In the additive market, ethanol behaves in a complimentary relationship with regular unleaded gasoline. For example, as regular unleaded gasoline prices increase, total motor fuel use declines and so does the demand for ethanol as an additive. However, in the E10 and E85 markets, ethanol behaves as a substitute for regular unleaded gasoline with demand for ethanol increasing as regular unleaded gasoline prices increase. In addition, as a substitute, ethanol has between 65 and 70% of the energy value of regular unleaded gasoline and should sell at a discount compared to regular unleaded gasoline. Labeling at the pump for E10 varies considerably across the US. In some states, gas pumps explicitly state that ethanol is included. In northeastern states, for example, gas pumps

do not label fuel as E10 or otherwise identify ethanol content below the 10% level, so consumers do not have a choice. Therefore, it is unclear whether consumers will fully be able to distinguish the fuel economy difference between the additive level and the E10 level and, as such, may not be as responsive to the ethanol/regular unleaded gasoline price ratio. The situation is different for E85 pumps, predominantly found in the Midwest, because they require labeling so flex-fuel vehicle owners can use it. Consumers can easily distinguish the difference between the fuel economy of E85 and regular unleaded gasoline and will likely be much more responsive to the ethanol/regular unleaded gasoline price ratio.

In order to determine the size of the ethanol additive market, motor fuel use (MFU) in Equation 5 is estimated as a function of the unleaded gasoline retail price (UGRP), income (INC), and a very small substitution effect from the retail price of ethanol (RETHP). The unleaded gasoline retail price (UGRP) is a function of an exogenous petroleum price index (PPIP), which is closely related to the price of crude oil. Motor fuel use and the retail unleaded gasoline price then impacts the demand for ethanol in various formulations.

$$MFU_t = f(UGRP_t, RETHP_t, INC_t) \quad (5)$$

The segment of additive ethanol demand, denoted as ETADD, reflects the replacement of the oxygenate Methyl tertiary-butyl ether, denoted as MTBE, in select markets and can be blended at less than 10% in motor fuels. Additive demand is a function of the wholesale ethanol price adjusted for the blenders' tax credit of \$0.51 cents per gallon (ETTAX), motor fuel use multiplied by the ethanol additive share required to meet oxygenate requirements (ETADSHR), and MTBE use. Demand for ethanol as an additive and replacement for MTBE in regions with oxygenate mandates results in a relatively inelastic response to wholesale ethanol prices.

For the non-additive use, demand is broken into retail market potential and market penetration for the E10 and E85 markets. Market potential for the two blends differs on the quantity of ethanol demand possible with up to 10% inclusion for E10 and up to 85% inclusion for E85. The E10 blend can be used in the vast majority of motor vehicles on the road today, making the potential market (E10MKT) in Equation 7 10% of motor fuel use less the ethanol additive share required to meet oxygenate requirements. The penetration of E10 into the market (E10PEN) in Equation 8 is a function of the ethanol to regular unleaded price ratio. The equation includes two different levels of responsiveness with

respect to the price ratio. When the ratio is larger than 75%, only the first term in the equation applies. The significance of the 75% is that it reflects the energy value of ethanol relative to regular unleaded gasoline with an allowance for ethanol's higher octane level. So, as the price ratio falls below 75%, ethanol is becoming more competitive with regular unleaded gasoline and consumer responsiveness should increase. Thus, the second term in the equation kinks the E10 demand from a relatively inelastic position to a very elastic demand that is highly responsive to price. Total ethanol demand in the E10 market (E10D) is then a product of market potential and market penetration (see Equation 9).

The market potential for E85 (E85MKT) in Equation 10 differs as its use is limited in the short-run to special 'flex fuel' vehicles and only sold in *some* retail outlets. Therefore this market is limited by costly investments required of consumers and retailers, but adoption is expected to increase over time, denoted as TREND, and may be accelerated or slowed depending upon the price ratio of ethanol and regular unleaded gasoline relative to ethanol's energy value. E85 market penetration (E85PEN) in Equation 11 is specified as a function of the same variables as E10 market penetration, but with different responsiveness and a lower price ratio of 70%. The E85 market's trigger ratio is lower than in the E10 market, which is intended to reflect the fact that E85 has to be competitive on an energy basis, but also captures the relatively smaller impact of the octane premium on a per-gallon-of-ethanol basis. For example, by assumption, the premium built into E10 for octane implies a 0.5 to 1% premium for the blend (5 to 10% premium relative to the energy value multiplied by a 10% inclusion rate). The octane premium for E85 will be much lower on a per-gallon-of-ethanol basis. If the blend value of ethanol's octane is 1%, that would imply only about a 1.35% premium above the energy value for E85 versus regular unleaded. The acceptance and use of E85 accelerates as the ratio of retail ethanol to unleaded gasoline prices falls below 70%, but is very unresponsive at ratios above this point. E85 demand (E85D) in Equation 12 is then a product of market potential and market penetration.

Total US ethanol demand (ETDMD) in Equation 13 is then the maximum of the aggregated demand across the additive, E10 and E85 markets, or the mandated quantities under the Renewable Fuel Standard (RFS) subtracting off biodiesel use (BIODSL).

$$ETADD_t = f((WETHP_t - ETTAX_t), MTBE, MFU_t * ETADSHR) \quad (6)$$

$$E10MKT_t = f(MFU_t, ADDAJ_t) \quad (7)$$

$$E10PEN_t = f(RETHP_t / UGRP_t, \max(0.75 - RETHP_t / UGRP_t)) \quad (8)$$

$$E10D_t = E10MKT_t \times E10PEN_t \quad (9)$$

$$E85MKT_t = f(E85MKT_{t-1}, TREND_t, \max(0.75 - RETHP_t / UGRP_t)) \quad (10)$$

$$E85PEN_t = f(RETHP_t / UGRP_t, \max(0.7 - RETHP_t / UGRP_t)) \quad (11)$$

$$E85D_t = E85MKT_t \times E85PEN_t \quad (12)$$

$$ETDMD_t = \max((ETADD_t + E10D_t + E85D_t), RFS - BIODSL) \quad (13)$$

Ethanol ending stocks (ETSTK) are specified as a function of wholesale ethanol *price* (reflecting speculative demand) and ethanol *production* (reflecting transaction demand). Net imports of ethanol (ETNIMP) are specified as a function of simulated world ethanol prices and domestic prices adjusted for the \$0.54 import tariff. The wholesale ethanol market closes on the standard supply equals demand identity (see Equation 14).

$$ETSTK_{t-1} + ETPROD_t + ETNIMP_t = ETDMD_t + ETSTK_t \quad (14)$$

Ethanol wholesale and retail prices are linked through an identity which includes the blenders' tax credit of \$0.51 a gallon and a wedge taken from the wholesale to retail price spread of unleaded gasoline (see Equation 15).

$$RETHP_t = WETHP_t - ETTAX + UGRP_t - UGWP_t \quad (15)$$

The structure of the biodiesel model is similar to ethanol, but is somewhat streamlined given the size of the industry. The smaller scale of biodiesel production leads to some simplifications and demand is not segmented into additive and blend markets, but in any case the model explicitly accounts for the \$1.00 tax credit to biodiesel blenders. Capacity and capacity utilization in the biodiesel markets are determined by net returns for biodiesel plants as published by the National Renewable Energy Laboratory (Tyson, Bozell, Wallace, Petersen, & Moens, 2004). The market is driven largely by soybean oil as a feedstock but also includes rapeseed oil, and other oils and fats.

## Methodology

FAPRI's January 2007 stochastic baseline is used as the basis for comparison in this analysis. The baseline forecast provides projections for the 2006/07 to 2016/17 period assuming current policies are extended. The baseline was initially developed deterministically, that is to say that exogenous variables in each year took single, non-varying values. A set of global econometric models maintained by FAPRI at the University of Missouri–Columbia, Iowa State University, and the University of Arkansas is solved over the given exogenous data to produce values for the endogenous variables relating to commodity market quantities and prices for each year. Once the global crops and livestock projections were completed, government costs and farm income projections were calculated for the US. After completion of the deterministic baseline, the partial stochastic baseline for the US crops, livestock, government costs, and farm income was developed. The partial stochastic baseline utilized the historically correlated distributions of crop yields and correlated distributions of the errors in key demand equations, including exports, to construct 500 possible scenarios based on the historical variability in these equations. It is only a partially stochastic exercise because the variability in the parameter estimates used in the economic models is not varied and the exogenous error terms from the minor equations are not replaced with random draws from probability distributions. However, partially stochastic analysis provides a perspective on the potential variability in results, which can be compared with historical variability.

The scenario in this study represents the scheduled expiration of the tax credits and the import tariff in the current law, which are assumed to continue in the baseline. The ethanol tariff and biodiesel tax credit are set to expire in 2008, while the ethanol tax credit is set to expire in 2010. In the scenario, the export tariff and biodiesel tax credits are removed beginning January 1, 2009 and the ethanol tax credit is removed on January 1, 2011. The renewable fuels mandate set by the Energy Act of 2005 is assumed to remain in place. In partially stochastic simulations, the scenario and the baseline are the results of simulations using the same correlated distribution draws so that the output data are directly comparable.

## Results

The impact of the loss of biofuel's tax credits and import tariff are presented for the 2011 to 2016 period (Table 1). These data reflect the annual means of the 500 sto-

chastic outcomes for both the baseline and the scenario. Therefore the values presented in the table are an average of 3,000 numbers (6 year period with 500 observations per year per variable).

On average, ethanol production declines by 3.75 billion gallons, or 30% from the baseline forecast, and wholesale ethanol prices fall \$0.29 per gallon (17.8%) with the removal of the tax credit. The implied retail price of ethanol increases by 12.5% due to the decline in ethanol production. In this scenario, much of the demand response comes from the E10 category. Demand in the additive category largely fills a mandated inclusion. E85 responds less in this scenario because ethanol prices rarely fall low enough to make it competitive. Relative responsiveness is sensitive to the starting point for prices and the direction of change. Other scenarios, including one which would reduce ethanol prices, would likely result in the biggest response in E85 demand as the ethanol to gasoline price ratio pushes demand to the more responsive part of the demand curve. Ethanol imports increase an average of 160 million gallons (49.4%) compared to baseline levels. While one might expect a larger increase in imports with the removal of the export tariff (Elobeid & Tokgoz, 2006), the magnitude is limited by the decline in domestic wholesale ethanol prices. Ethanol dry mill net returns to fixed investment drop to \$0.04 cents per gallon, down \$0.15 from the baseline average. This net return stops investment in ethanol plants since the average fixed costs of investment is approximately \$0.24 cents per gallon (Elobeid et al., 2006). Certainly there is some variation in average fixed and variable costs across ethanol plants. If all plants were identical and returns over operating costs remained positive, then plants should operate at normal capacity. Within the stochastic results, some outcomes produced ethanol returns which were actually negative, suggesting that while many plants may not be making a profit, other plants continued to cover operating costs.

Corn prices decline by \$0.30 per bushel due to the reduction in ethanol processor demand. With lower corn prices and less competition from distillers' grains, corn feed demand increases by 6.8% (400 million bushels) while export demand increases by 16.9% (400 million bushels also). Corn exports are more price elastic than corn feed demand, which results in a larger proportional increase in exports. Corn-planted acreage falls by 3.38 million acres to 86.5 million acres, driving down corn production by 520 million bushels as corn prices weaken relative to other crops. Wheat and soybean acreage increases by 0.54 and 1.10 million acres, respec-

Table 1. Biofuel tax and tariff expiration: 2011-2016 averages.

	Tax provisions extended indefinitely	Tax provisions expire as scheduled	Absolute difference	Percentage difference
<b>Tax and tariff provisions</b>		<b>(Dollars per gallon)</b>		
Ethanol tax credit	0.51	0.00	-0.51	-100.0%
Biodiesel tax credit (virgin oil)	1.00	0.00	-1.00	-100.0%
Ethanol specific tariff	0.54	0.00	-0.54	-100.0%
<b>Biofuel sector results</b>		<b>(Billion gallons)</b>		
Ethanol production	12.37	8.61	-3.75	-30.4%
Ethanol net imports	0.32	0.48	0.16	49.4%
Ethanol domestic disappearance	12.68	9.11	-3.57	-28.1%
Biodiesel production	0.51	0.23	-0.27	-53.9%
		<b>(Dollars per gallon)</b>		
Ethanol price, FOB Omaha plant	1.63	1.34	-0.29	-17.8%
Ethanol implied retail price	1.76	1.98	0.22	12.5%
Dry mill returns over operating costs	0.19	0.04	-0.15	-79.7%
Biodiesel plant price	3.07	2.12	-0.95	-31.0%
<b>Corn sector supply and use</b>		<b>(Billion bushels)</b>		
Corn production	13.83	13.31	-0.52	-3.7%
Corn ethanol use	4.14	2.82	-1.33	-32.1%
Corn feed use	5.84	6.24	0.40	6.8%
Corn exports	2.37	2.77	0.40	16.9%
<b>Soybean sector supply and use</b>		<b>(Billion bushels)</b>		
Soybean production	3.05	3.10	0.05	1.6%
Soybean crush	1.92	1.92	0.01	0.3%
Soybean exports	0.95	0.99	0.03	3.4%
		<b>(Billion pounds)</b>		
Soyoil biodiesel use	2.95	1.33	-1.62	-55.0%
Soyoil other domestic use	17.11	17.73	0.62	3.6%
Soyoil exports	1.85	2.91	1.07	57.9%
<b>Crop planted acreage</b>		<b>(Million acres)</b>		
Corn	89.84	86.46	-3.38	-3.8%
Soybeans	70.08	71.18	1.10	1.6%
Wheat	57.46	58.00	0.54	0.9%
9 other crops plus hay	96.42	96.40	-0.03	0.0%
Conservation reserve area	31.95	32.60	0.65	2.0%
12 crops + hay + CRP	345.76	344.64	-1.11	-0.3%
<b>Crop sector prices</b>		<b>(Dollars per bushel)</b>		
Corn farm price	3.11	2.81	-0.30	-9.6%
Soybean farm price	6.63	6.14	-0.49	-7.4%
Wheat farm price	4.19	4.03	-0.16	-3.9%
Sorghum farm price	3.01	2.81	-0.20	-6.6%
		<b>(Cents per pound)</b>		
Upland cotton farm price	58.10	57.85	-0.26	-0.4%
Soyoil market price, Decatur	34.34	26.89	-7.45	-21.7%

**Table 1. Biofuel tax and tariff expiration: 2011-2016 averages.**

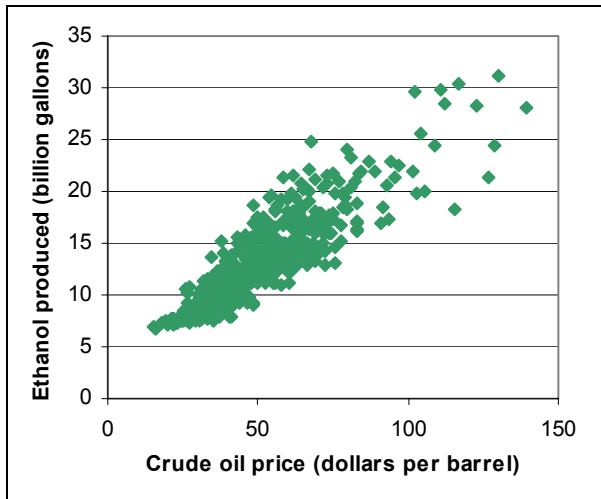
	Tax provisions extended indefinitely	Tax provisions expire as scheduled	Absolute difference	Percentage difference
	(Dollars per ton)			
Soymeal price, 48% protein	166.09	179.85	13.75	8.3%
Distillers' grain price, Indiana	102.39	113.35	10.96	10.7%
<b>Tax and tariff provisions</b>	(Dollars per gallon)			
Ethanol tax credit	0.51	0.00	-0.51	-100.0%
Biodiesel tax credit (virgin oil)	1.00	0.00	-1.00	-100.0%
Ethanol specific tariff	0.54	0.00	-0.54	-100.0%
<b>Meat and milk production</b>	(Billion pounds)			
Beef production	28.39	28.44	0.05	0.2%
Pork production	22.56	22.65	0.09	0.4%
Broiler production	39.73	39.87	0.14	0.3%
Milk production	199.66	199.93	0.27	0.1%
<b>Livestock and dairy prices</b>	(Dollars per hundredweight)			
Steers, Nebraska direct	84.61	84.13	-0.48	-0.6%
Feeder steers, Oklahoma City	100.55	101.11	0.55	0.5%
Barrows & gifts, 51-52% lean	49.75	48.97	-0.78	-11.6%
Broilers, 12-city wholesale	70.82	70.08	-0.74	-1.0%
All milk	14.47	14.41	-0.06	-0.4%
<b>Government outlays</b>	(Billion dollars)			
Marketing loans (crop years)	0.59	0.93	0.34	56.9%
Countercyclical payments (crop years)	0.90	1.13	0.23	25.2%
Net CCC outlays (fiscal years)	11.17	11.74	0.57	5.1%
Ethanol tax credit	6.47	0.00	-6.47	-100.0%
<b>Farm income</b>	(Billion dollars)			
Crop receipts	154.06	147.34	-6.72	-4.4%
Livestock receipts	134.16	133.54	-0.61	-0.5%
Government payments	11.06	11.63	0.57	5.1%
Rent to non-operator landlords	14.13	12.44	-1.69	-12.0%
Other production expenses	270.78	268.54	-2.24	-0.8%
Total production expenses	284.92	280.98	-3.93	-1.4%
Other net farm income	46.64	46.38	-0.27	-0.6%
Net farm income	61.00	57.91	-3.09	-5.1%
	(Dollars per acre)			
<b>Value of farm real estate</b>	2,746	2,670	-75.23	-2.7%
	(Index)			
<b>Consumer food price index</b>	228.6	228.4	-0.2	-0.1%

Note: Some totals may not add correctly due to rounding.

tively. Relative to the FAPRI baseline, CAP acres also increase by 0.65 million acres, while 1.11 million marginal acres do not remain in production.

Biodiesel prices fall an average of \$0.95 per gallon with the elimination of the \$1.00-per-gallon tax credit.

Because the biodiesel industry is more heavily dependent than the ethanol industry on the tax credit because of tighter profit margins biodiesel production falls 53.9%, or 270 million gallons, from the baseline. With vegetable oil prices very sensitive to additional demand,



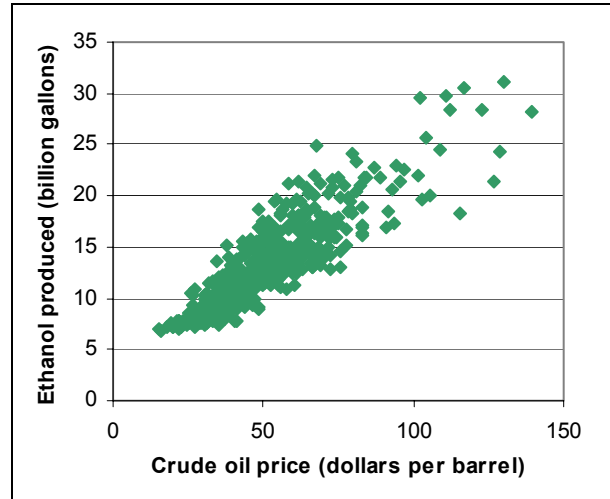
**Figure 1. Crude oil prices and ethanol production stochastic baseline results for 2016.**

average biodiesel returns were marginal even with an extension of the tax credit in the baseline. Without the tax credit, biodiesel returns and production decline sharply.

Soybean prices fall an average of \$0.49 per bushel with an expansion in soybean area due to less competition from corn and a 21.7% decline in soybean oil prices. Meal prices increase by 8.3% with less competition from distillers' dried grains and stronger demand from the livestock sector.

Lower feed prices stimulate livestock production with beef, pork, and broiler production up 0.2%, 0.4%, and 0.3%, respectively. Fed livestock prices are marginally weaker with more production, but feeder steer prices are 0.5% higher. Lower feed costs would, all else equal, increase profits in feedlots, resulting in higher input prices (feed steer prices) and lower output prices (steer prices) when markets adjust.

The scenario indicates that annual government costs decrease by an average of \$6.5 billion if fuel taxes credits on ethanol and biodiesel are permitted to expire, while expenditures on farm programs expand by \$0.57 billion. The elimination of the tariff also has a small effect on government outlays for farm programs, reducing marketing loan payments and countercyclical payments by a marketing year annual average of \$0.34 billion and \$0.23 billion, respectively. Farm income falls by \$3.1 billion per year on average despite a reduction in expenses of \$3.9 billion per year. Interestingly, both crop and livestock receipts decline as additional livestock production is more than offset by lower livestock prices. Average land values are \$75 per acre lower under the scenario, falling to an average of \$2,670 per



**Figure 2. Crude oil prices and ethanol production stochastic scenario results for 2016.**

acre compared with \$2,746 per acre in the baseline. Land rents are also lower, with a decline in rent to non-operator landlords of \$1.7 billion. Consumer prices are marginally lower, with a 0.1% decline in the consumer price index for food under the scenario.

Stochastic analysis provides additional insight into the potential variability around the results. Figures 1 and 2 present the baseline and scenario stochastic results for ethanol production versus crude oil price. Clearly, allowing the biofuels credit and import tariff to expire has significant implications for the growth in ethanol production even in the event that oil prices are substantially higher than current levels. For example, at \$80 per barrel crude oil, the baseline results include several possible ethanol production points above 20 billion gallons. However, under the scenario of no further support, at \$80 per barrel crude oil, the highest ethanol production point is 15 billion gallons. It is also interesting to notice how under low crude oil prices (less than \$45 per barrel), the scenario tends to trace out ethanol production levels at or slightly below the mandated consumption levels in the 2005 Energy Act. In fact, the weaker oil prices become, the more ethanol imports begin to replace US ethanol production because of the lower cost of producing ethanol from sugarcane in Brazil.

The situation for biodiesel is more complex because vegetable oil represents 82% of the variable cost of biodiesel production where as corn accounts for 65% of the cost of ethanol production. Removal of the biodiesel tax credit for virgin oils quickly pushes biodiesel operating margins substantially into the red, dropping biodiesel production. In Figure 3, the baseline results suggest that soydiesel production has no relationship with crude

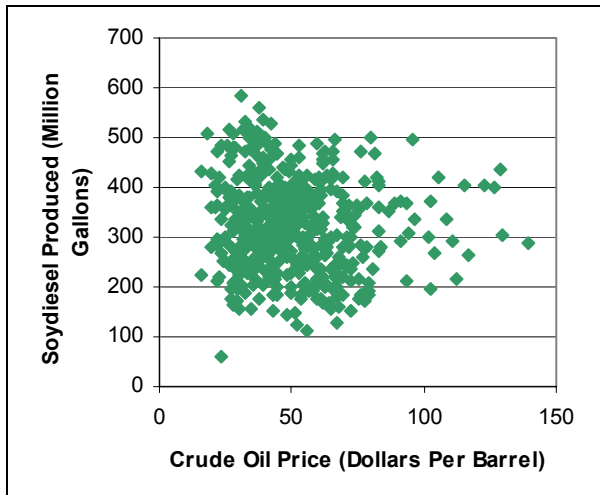


Figure 3. Crude oil prices and soydiesel production stochastic baseline results for 2016.

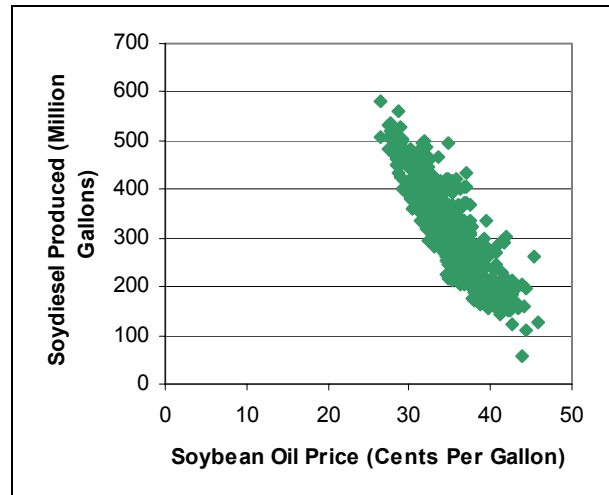


Figure 5. Soybean oil prices and soydiesel production stochastic baseline results for 2016.

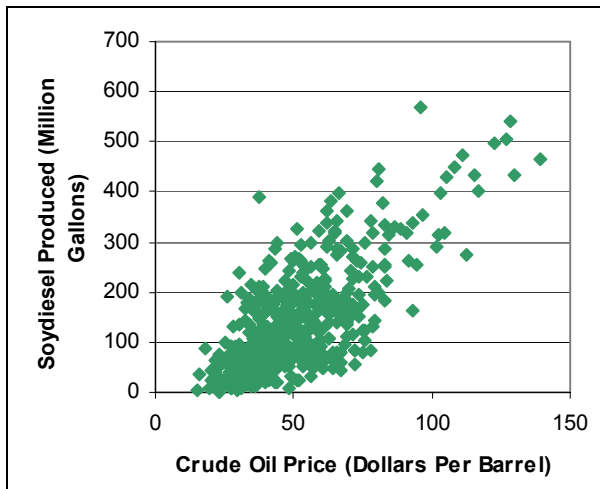


Figure 4. Crude oil prices and soydiesel production stochastic scenario results for 2016.

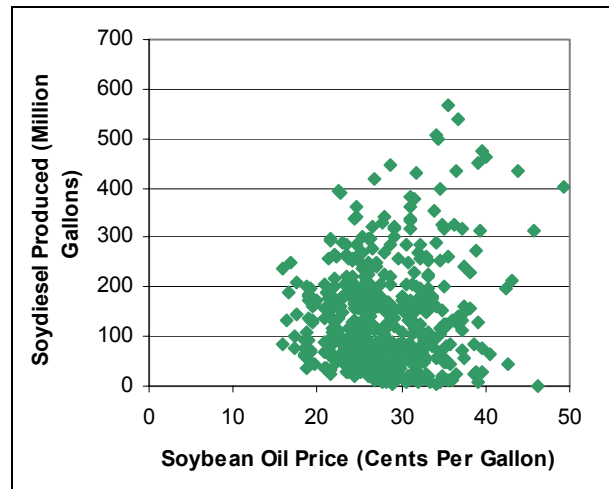


Figure 6. Soybean oil prices and soydiesel production stochastic scenario results for 2016.

oil price. However, this outcome is not because higher crude oil prices do not increase biodiesel prices, but because soybean oil prices increase more rapidly from a variety of interrelated factors. Among these factors are the spillover impacts from ethanol on biodiesel. In the baseline, ethanol production increases corn prices and reduces soybean acreage planted, increasing soybean prices relative to the no-tax-credit-extension scenario. In addition, in the baseline, soybean meal prices are pressured lower through greater production of DDGs, reducing the incentive to crush soybeans, which pushes up soybean oil prices. Therefore, the net effect of higher petroleum prices is a disproportionate increase in soybean oil prices, which actually dominates the positive effect of higher petroleum prices on biodiesel prices

(Figure 5). In Figure 4, crude oil prices seem to have a larger impact, but this is because soybean oil prices tend to be lower under the scenario due to less biodiesel production and less spillover impacts from ethanol. In Figure 6, the scenario results suggest that soydiesel production has no relationship with soybean oil prices, but this is because soybean oil prices are low compared with the baseline, making the biodiesel profit margin more sensitive to changes in crude oil prices.

### Conclusions

The analysis presented above shows the degree to which biofuel industries in the US are dependent on public financial support. In the event that the biofuel tax credits

and ethanol import tariff are permitted to expire, the ethanol production would contract by 30% and biodiesel production by more than half. These results even take into account the recent surge in capacity, but net returns would fall so dramatically that many of these plants would be unused for their inability even to cover operating costs.

An improvement this study offers relative to preceding analysis is the inclusion of ethanol imports and the relevant import tariff. Whereas previous studies have implicitly assumed a series of uninterrupted links connecting corn and oil prices, passing through the ethanol market without fail, the model described above explicitly represents the market-clearing identity of the ethanol and corn markets, permitting trade to affect each. In particular, the implications of changes in ethanol policy – certainly the ethanol import tariff – or conditioning factors, such as the oil price on the corn market, depend appropriately on the responsiveness of ethanol imports. In the event of concurrent elimination of the tax credit that subsidizes ethanol use and the tariff that limits production, effects partly counteract each other but nevertheless lead to an increase of the likely very low level of imports by half.

The effect of less government subsidy to biofuel is lower government costs. The expiration of the tax credit saves taxpayers \$6.5 billion on average. The ethanol tariff expiration reduces government revenue, but the quantities imported at this rate are likely to be low, so little revenue is lost. On the other hand, agricultural policies that pay more when prices fall are then activated, raising government costs by more than \$0.57 billion on average. The net effect is \$5.9 billion less government expenditure.

Reducing a subsidy and tariff that support production of goods made from crop inputs lowers farm income. Corn producers lose a substantial amount of income as the second largest category of demand decreases, but the effects of dramatically lower biodiesel and cross-crop substitution distributes losses among all crop producers. Livestock producers pay lower feed costs, but their inclination to raise output in response leads to falling output prices as quantities move along an inelastic demand. Moreover, considering overall net farm income, the savings of livestock producers on feed costs is enabled by the lower output prices crop producers receive. The aggregate loss, on average, is \$3 billion.

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