The Effect of Oil Price Variability on Biofuel Production

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Overview

Background

As concerns about the availability of crude oil have been brought to the forefront of energy discussions, renewable energy sources have also come to the attention of policy-makers, energy firms, renewable energy activists, and consumers.

Technological improvements are increasing demand for energy in all countries, especially in emerging economies, such as India and China. The necessity to find alternative energy sources becomes even more critical not only in the United States but globally.

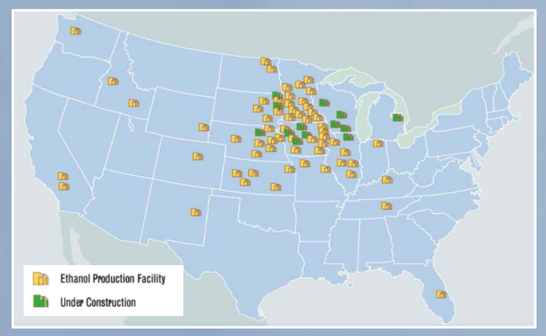
One particularly recognizable source of renewable and sustainable energy is biofuel.

Biofuel as an Economic Product

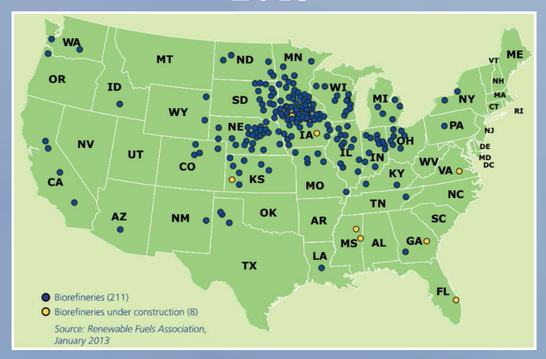
- Biofuels have been economically linked to oil since the 1970s, when the U.S. launched Project Independence to minimize vulnerability to foreign oil producers by investing in sustainable energy sources
- The role of ethanol as a gasoline additive further reinforces the connection between oil and biofuels
- Economic studies of biofuel in its early stages determine that ethanol can only compete with the dominating oil market if the blenders' fuel tax credit remains in place
- Furthermore, growth in the ethanol industry will eventually put upward pressure on food prices
- Pre-existing market structures and cost disadvantages provide obstacles for biofuel in developing its own market

U.S. Biorefineries Over Time

2002



2013



Research Question and Objectives

To what extent does the volatility of oil prices affect the production or output of biofuels?

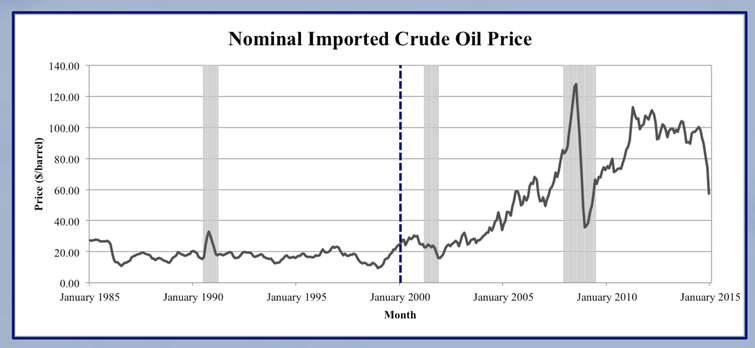
Objectives:

1. Analyze the trend in oil prices from 1985 to 2014
2. Evaluate the trend in biofuel production opportunities from 1985 to 2014
3. Determine the effect of the volatility of oil prices on bioethanol production

Research Question and Objectives

Objectives 1 and 2

We graph the data on scatter plots to analyze overall trends from 1985 to 2014 (recession months are shaded gray). We also dichotomize the data sets into two distinct periods: **Period A: 1985-1999**, and **Period B: 2000-2014**.



The average monthly growth rate for oil prices was -0.1% in Period A, and 0.97% in Period B. Overall, the average monthly growth rate was 0.58%.

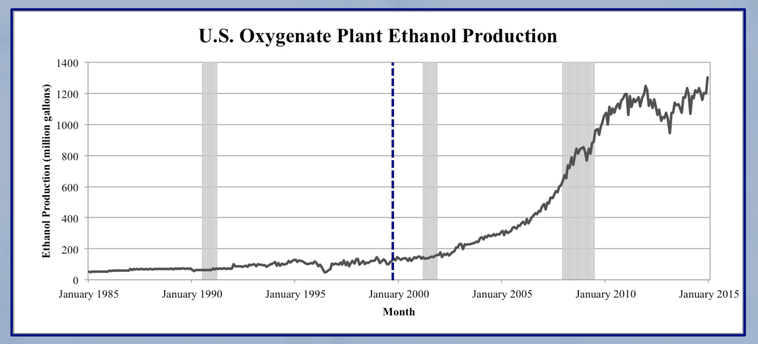
The average monthly growth rate for bioethanol production was 0.46% in Period A, and 1.48% in Period B. Overall, the average monthly growth rate was 0.98%.

Objective 3

To address Objective 3, we create a model that describes bioethanol production as a function of oil price variability (σ_t), which was calculated by taking the natural log of average monthly oil prices.

$$Q_t = f(\sigma_t, c_{t-k}, s_{t-k}, T_t, m_t, D)$$

We also account for the following factors which may influence ethanol production: **corn prices** (c_t) and **soybean prices** (s_t), the value of the **blenders' fuel tax credit** (T_t), and a dummy variable describing **whether the American economy is in recession** (m_t). We also consider a dummy variable D which describes whether the period under consideration is in Period A or Period B.



Variable	Coefficient	Std. Error	95% Confidence Interval	
Ln Nominal Imported Crude Oil Price	186.05***	15.63	160.66	222.14
U.S. Monthly Average Soybean Price	62.13***	5.85	49.58	72.60
Value of Blenders' Fuel Tax Credit	-3113.30***	212.42	-3440.16	-2604.63
Recession Month	-58.10***	18.82	-96.17	-22.13
U.S. Monthly Average Corn Price	-35.79***	11.55	-56.44	-11.00
Constant	1024.31***	152.77	660.37	1261.26

*** significance at the 1% level

The R-squared value was 0.9301, indicating that the variables in the model explain about 93% of the variability in the dependent variable. Overall, the model was statistically significant at the 1% level, with an F-value (5, 354) of 942.25.

The model was estimated using a stepwise regression technique, with variables allowed entry to the model if their statistical significance was 5% or lower. This approach is most efficient in the following situations:

- When there is little theory to guide the selection of variables to include in the model;
- When there is a need to explore which exogenous variables provide a good fit to the model; and
- When the model's prediction performance needs to be improved by reducing the variance resulting from including unnecessary terms.

Conclusions

We can express the results of Objective 3 as a function that describes the expected production of bioethanol per month based on a set of input variables:

$$Q_t = 1024.31 + 186.05\,\sigma_t + 62.13\,s_t - 3113.30\,T_t - 58.10\,m_t - 35.79\,c_t$$

where the following are the coefficient estimates of the regression model:

Q_t is the output of bioethanol in each period t,

σ_t is the volatility (natural log) of crude oil prices in period t,

s_t is the price of soybeans, lagged by k periods,

T_t is the value of the biofuel tax credit during period t,

m_t is a dummy variable describing whether the American economy is in recession during period t, and

c_t is the price of corn, lagged by k periods.

Interpretation

1% increase in nominal crude oil price

→ 186.05 million gallon increase in ethanol production

Increases in oil price variability increases the attractiveness of bioethanol as a product

$1.00 increase in U.S. soybean price

→ 62.13 million gallon increase in ethanol production

Since soybeans are a biodiesel input, and bioethanol is a substitute for biodiesel, this is equivalent to an increase in the cost of biodiesel, so bioethanol is favored

$1.00 increase in per-gallon value of blenders' tax credit

→ 3113.30 million gallon decrease in ethanol production

This effect should be explored more thoroughly, as it may be a misspecification due to lack of variability in the value of the tax credit over the period of study

1 month of recession

→ 58.10 million gallon decrease in ethanol production

Bioethanol production is not immune to adverse macroeconomic conditions

$1.00 increase in U.S. corn price

→ 35.79 million gallon decrease in ethanol production

Since corn is a major input for bioethanol, any increases in input prices will drive up production costs

Future Research

- Including biodiesel in the measurement of biofuel production
- Using a different measure of government biofuel policy

This model is useful because it not only significantly explains past changes in biofuel development, but can also be used for estimating the future of biofuels in the United States.

Acknowledgement

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