

Biofuels Producers and Oil Price Risks (Work in Progress)

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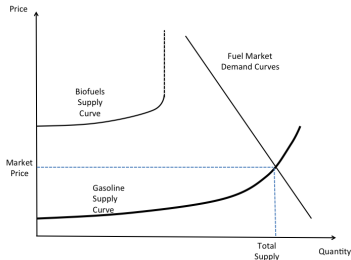
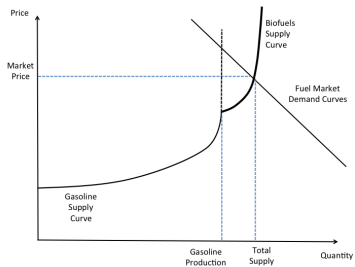
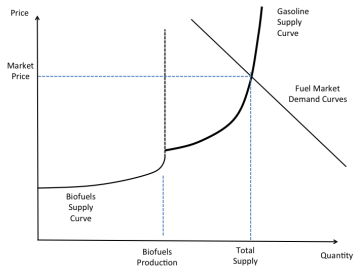
Motivation

- Current market: fairly separate gasoline and ethanol markets in the US
- Connection through the RIN mechanism
- Possible future scenarios: E25-E40, E85, deregulated market (zero price of RINs), export
- Almost perfect substitutions between gasoline and ethanol
- Volatile cash-flow regimes for ethanol producers

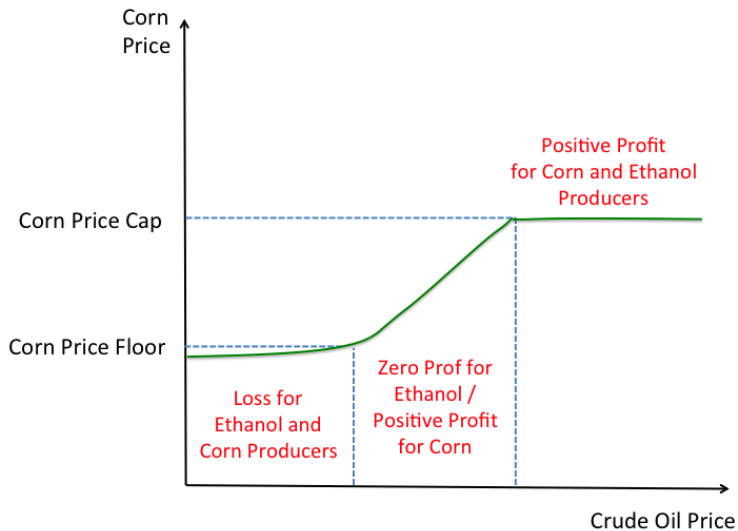
Volatile and Free Cash-Flow Problem

- Agency costs
- Bankruptcy costs
- Higher cost of capital
- Delayed investment

Supply Curves



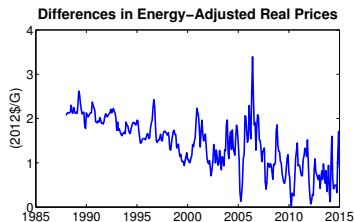
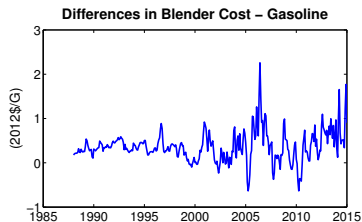
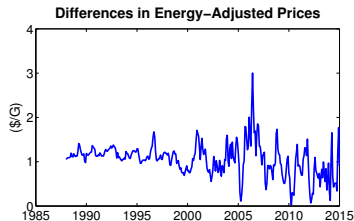
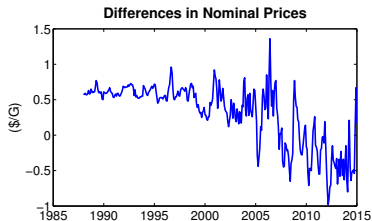
Crude Oil Price Levels and Corn Price



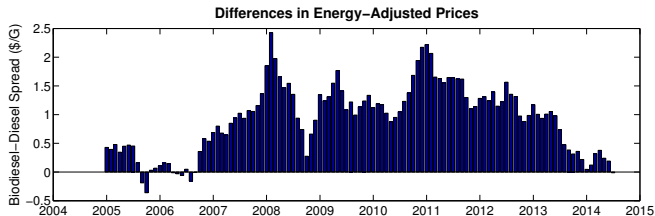
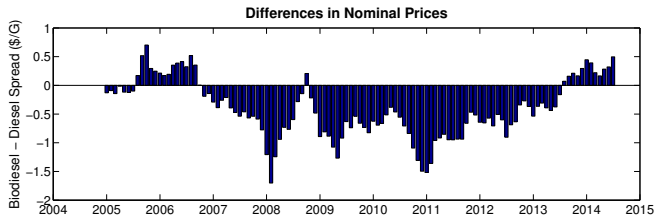
Biofuels Producers' Profit Process

- Similar to a spread option:
 - $\pi = \text{Max}\{\textit{Gasoline} - \textit{Ethanol}, 0\}$
- Dynamics of spread between biofuels (ethanol / biodiesel) and refined products (gasoline/diesel)
- Results from previous literature: positive impact of individual volatility, negative impact of correlation

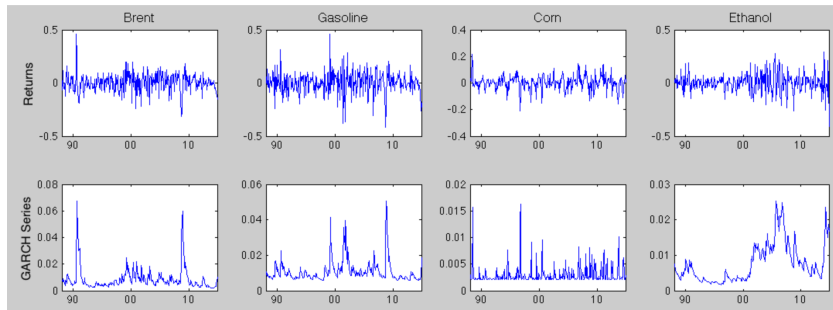
Spread between Ethanol and Gasoline Prices



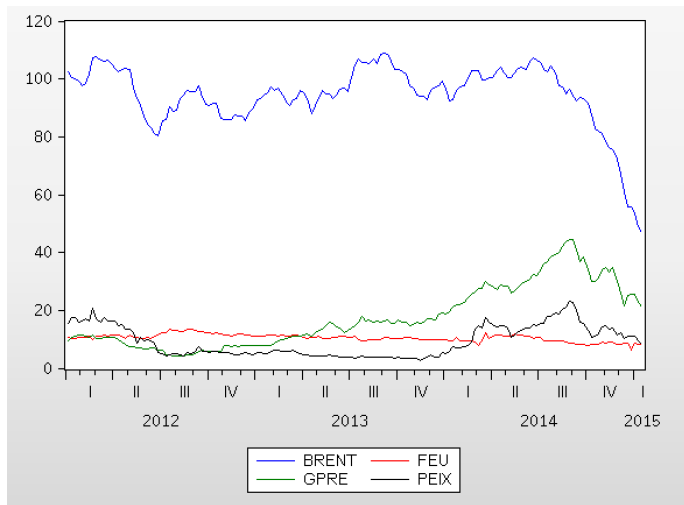
Spread between Biodiesel and Diesel



Returns and Volatility of Prices



Stock Market View: Oil Prices and Biofuels Assets



Crude Oil Beta of Biofuels Stocks

$$r_b = r_f + \beta_m r_m + \beta_O r_{\text{Crude Oil}} + \text{Other Controls}$$

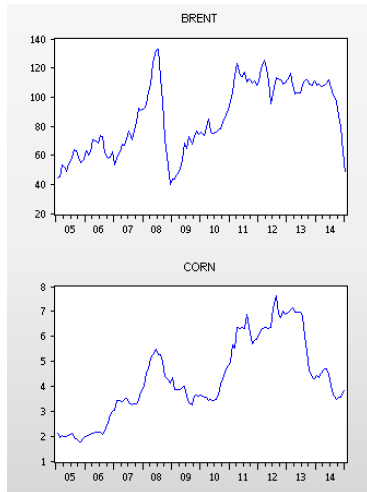
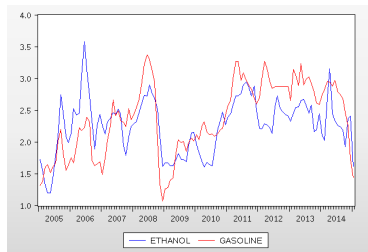
	Crude Oil Beta		
Asset	Full Sample	2010-2015	2012-2015
GPRE	0.27	0.34	0.58
REGI	0.27		0.27
FEU	0.49	0.54	0.49

Simulation Exercise: Assumptions

- Corn prices driven by random shocks to corn supply, demand for food, and a constant demand shift from the biofuels sector
- No causal effect from crude oil price on corn prices
- Biofuels producers profit = ethanol - gasoline spread + price of by-products

Structural Break in Gasoline and Ethanol Prices

- Bai Perron (2003) test of unit-root with structural breaks



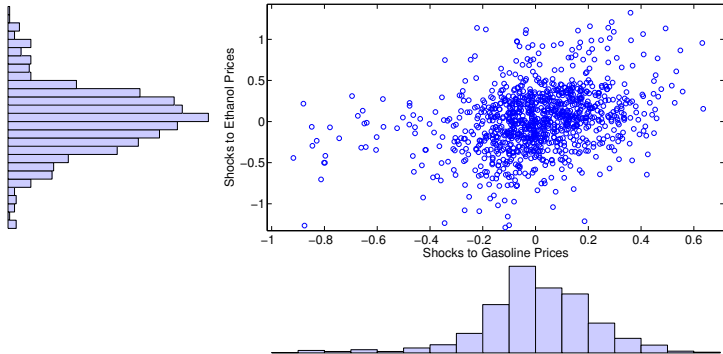
Unit Root Tests

Variable	Post 2005		Full Sample	
	ADF (Level)	ADF (L/T)	ADF (Level)	ADF (L/T)
Crude Oil	-2.63*	-2.33*	-1.93	-3.00
Gasoline	-3.05**	-2.95	-2.04	-3.22*
Ethanol	-3.05**	-9.23***	-2.58*	-3.41*
Corn	-1.64	-1.16	-2.07	-2.63

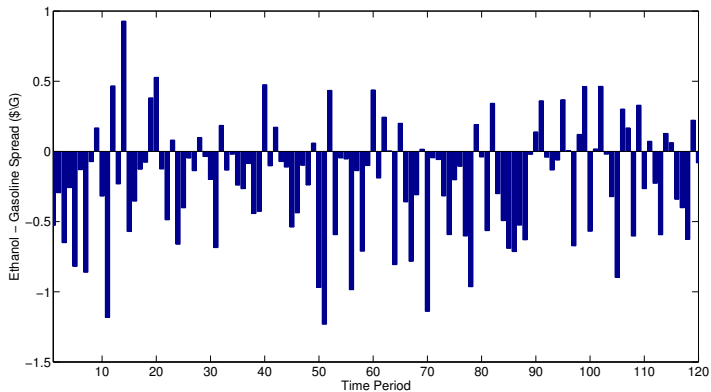
Modeling Joint Distribution

- Relaxing joint-normality assumption
- Copula methods:
 - Generate joint distribution from individual marginals
 - Taking into account tail and extreme dependences
- Individual price process assumptions: mean-reverting
- Monte Carlo simulation for 120 months (1000 trials)
- Equal starting prices (2.5 \$G)

Scatter Plot of Simulated Shocks



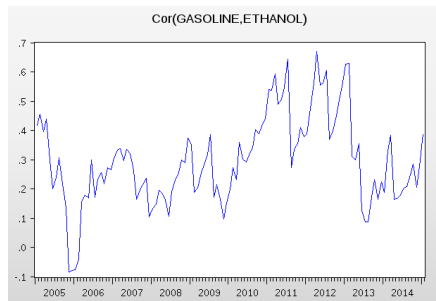
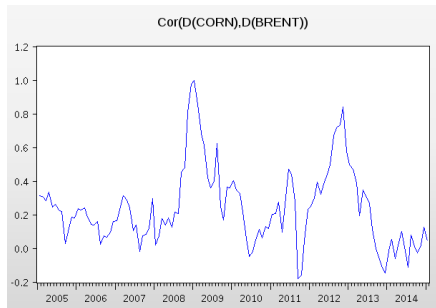
Average Path of Ethanol - Gasoline Spread



Sensitivity Analysis

- GBM instead of Mean-Reverting
- Time-varying correlations
 - Higher correlation of shocks to the two market \Rightarrow less uncertainty (and skewness) of profit process
 - VECM GARCH (BEKK) Model
 - Conditional correlation

Dynamic Correlations



Next Steps:

- Endogenous price of corn: SVAR estimation
- Learning effects and cost reductions in the biofuels sectors
- Price cap for the crude oil (caused by tight oil, tar sands, and oil shales)

Policy Implications and Solutions

- Export markets
- Flexible production technology
- Flexible tax and subsidy mechanism
- Risk-sharing contracts
- Horizontal diversification (portfolio of fossil fuel and biofuels)

Conclusion

- Spread between gasoline and ethanol as a stochastic process
- Response of biofuels assets to crude oil price shocks
- Structural break in gasoline/ethanol price processes
- Copula-based simulation, skewed profit process