AN EXAMINATION OF THE RELATIONSHIP BETWEEN BIODIESEL AND SOYBEAN OIL PRICES USING AN ASSET PRICING MODEL

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Introduction

- Feedstock (vegetable oils) costs usually account for between 80% and 90% of the total costs of production
- Given the installed capacity to convert soybean oil into biodiesel, margins to biodiesel productions should not open beyond certain quantities that allow plants to earn a normal profit.
- Large literature analyzing the relationship between the prices of energy and commodities, mostly on crude oil or gasoline and corn. Much less attention paid to the relation between biodiesel prices and their feedstock

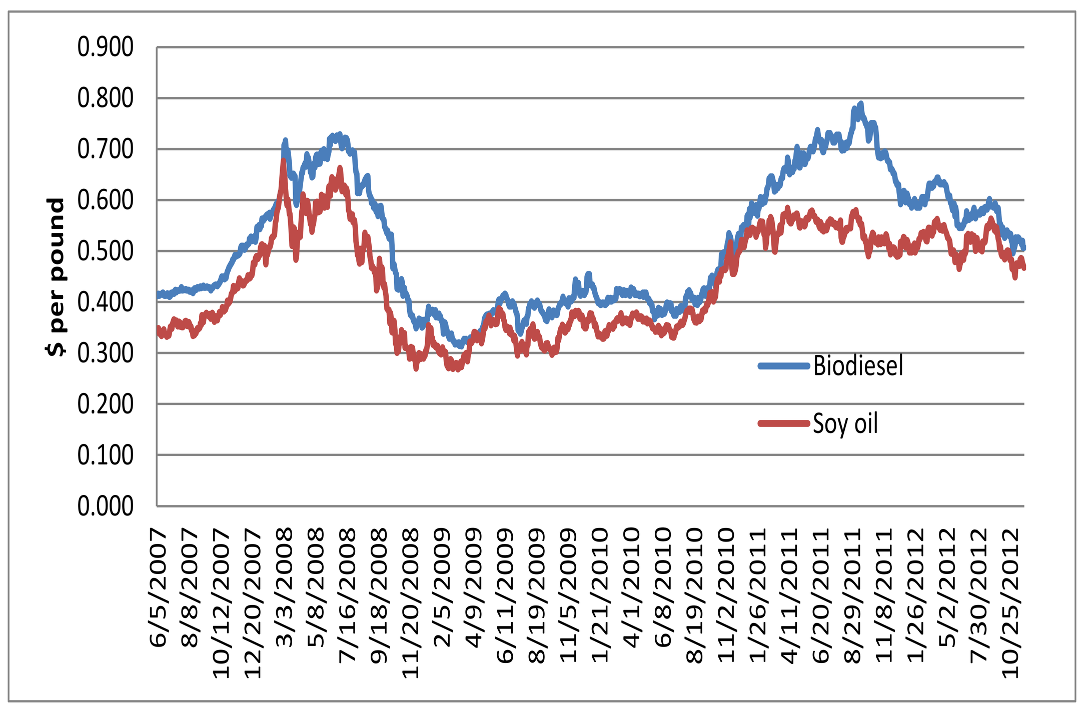


Figure 1. Daily prices of biodiesel and soybean oil

Stylized facts and hypothesis

•Biodiesel production raised rapidly in recent yeas

•Soybean oil, is the main feedstock for biodiesel production in the U.S.

•It's price should be related to the price of biodiesel

Year	Vegetable oil		Animal Fats	Recycled feeds	Other	Total
	Other	Soybeans				
	million pounds					
2010	358	1,141	645	286	33	2,463
2011	1,151	4,153	1,289	666	27	7,286
2012	1,358	4,023	1,010	900	1	7,292
	% of total					
2010	15%	46%	26%	12%	1%	100%
2011	16%	57%	18%	9%	0%	100%
2012	19%	55%	14%	12%	0%	100%

Table 1. Feedstock Used for Biodiesel Production in the US

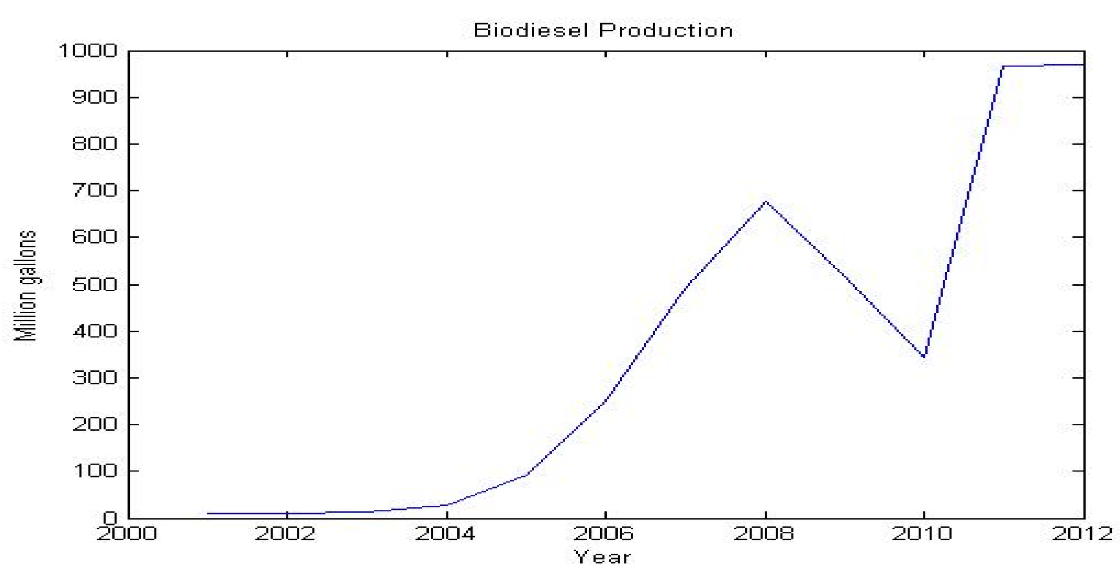


Figure 1: Recent evolution of biodiesel production levels in the U.S

Asset pricing model

- Empirical models of asset pricing attempt to extract information about latent state variables and structural parameters from observed prices.
- These models can involve high dimension latent state variables, can be conveniently estimated using Bayesian methods
- As the variables that modulate the valuation of soybean oil as a major input for biodiesel production are not observable, we will utilize and estimate a model commonly used in the asset pricing literature, when latent variables are involved.
- These methods treat the parameters of the models as random variables, having a distribution, which depends on observed state variables X and dependent variables Y.

$$\begin{cases} y_{t+1} = \mu_t + \sigma_y \varepsilon^y_{t+1} \\ \mu_{t+1} = E_\mu + \beta\left(\mu_t - E_\mu\right) + \gamma Z_{t+1} + \sigma_\mu \varepsilon^\mu_{t+1} \end{cases}$$

With ε^y_{t+1} and ε^μ_{t+1} $N\left(0,1\right)$

and $corr(\varepsilon^y_{t+1}, \varepsilon^\mu_{t+1}) = \rho$

$$\begin{pmatrix} y_{t+1} \\ \mu_{t+1} \end{pmatrix} \Bigg| \mu_t, Z_t, \Theta \sim N\left(\begin{bmatrix} \mu_t \\ E_\mu + \beta(\mu_t - E_\mu) + \gamma Z_{t+1} \end{bmatrix}, \begin{bmatrix} \sigma_y^2 & \rho\sigma_y\sigma_\mu \\ \rho\sigma_y\sigma_\mu & \sigma_\mu^2 \end{bmatrix} \right)$$

MCMC Methods used to estimate the model parameters $\underline{\mu} = \left\{\mu_t\right\}_{t=1}^{T}$ and $\Theta = \left\{E_\mu, \beta, \sigma_y, \sigma_\mu, \rho, \gamma\right\}$

Simulation study

To assess the ability of the used methods to estimate the parameters of the model, a simulations study is conducted

	E_μ	β	σ_y	σ_μ	ρ	γ
Initial value	0.05	0.5	1	1	0.5	0.1
True parameter	0.1	0.9	0.15	0.1	-0.5	0.5
Posterior mean	0.0988	0.8997	0.1551	0.0987	-0.5182	0.4991
RSME of posterior	0.0475	0.0038	0.0246	0.0119	0.1092	0.0092

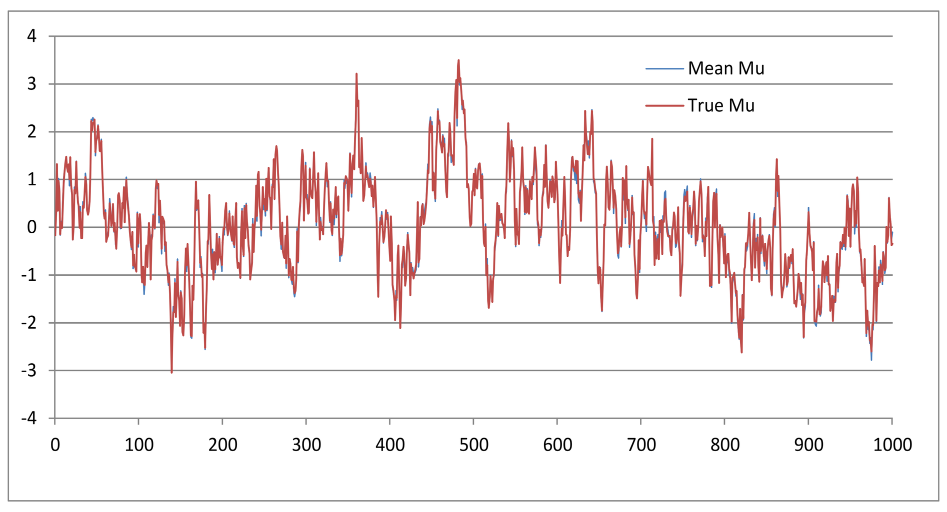
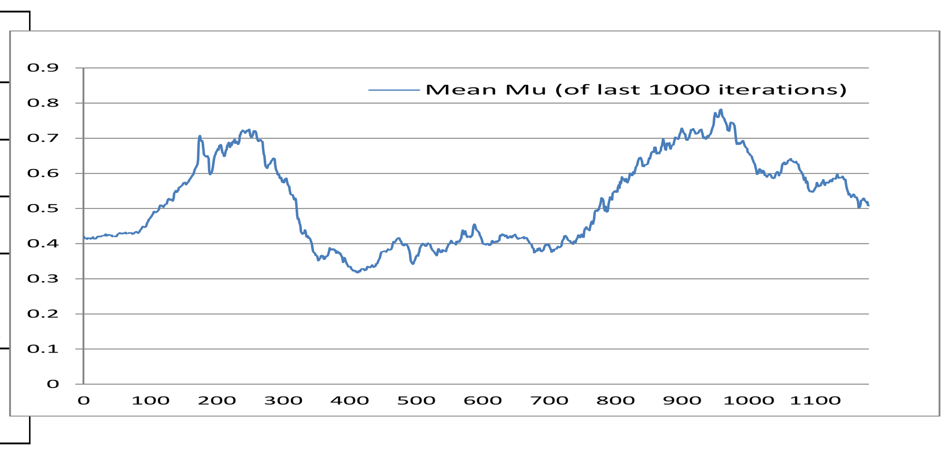


Table 2. True versus simulated parameters

Application to real data; Results

Daily observations for the pair of biodiesel and soybean oil prices for the period June 2007 to December 2012 were collected and used to estimate the model, yielding the following results

	E_μ	β	σ_y	σ_μ	ρ	γ
Starting point	1.0E-04	0.5	1.0	1.0	0.5	0.1
Mean of posterior	-0.044	0.964	0.045	0.037	0.930	0.058
std of posterior	0.335	0.020	0.005	0.005	0.015	0.037
2.5% Quantile of posterior	-0.774	0.917	0.040	0.029	0.899	-0.002
97.5% Quantile of posterior	0.629	0.998	0.060	0.051	0.960	0.125



The parameter γ is likely positive $P\left(\gamma > 0\right) > 0.95$ but small, indicating the price of soybean oil has a small direct impact on the price of biodiesel

The price of biodiesel seems to be more strongly driven in the short run by factors affecting the path of the latent variables than by the price of soybean oil (as reflected by β

Final remarks

This work utilized a discrete time return model of finance to analyze whether prices changes of soybean oil, the main feedstock for biodiesel production in the US affect the prices of biodiesel

Model parameters were estimated using MCMC methods, which were first shown to be able to identify the both the model parameters and the latent variables involved

Results from this study indicate the price of soybean oil does not have a strong direct impact on the price of biodiesel in the short run, or in a daily basis

This study analyzed only whether the price of soybean oil drove the price of biodiesel (at a daily frequency). In particular, it did not use lower frequency to analyze equilibrium relationship, and it did not attempt to analyze whether the price of biodiesel affected that of soybean oil.

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