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Price Volatility Transmission: Linking the U.S. Crude Oil, Corn and Plastics Markets

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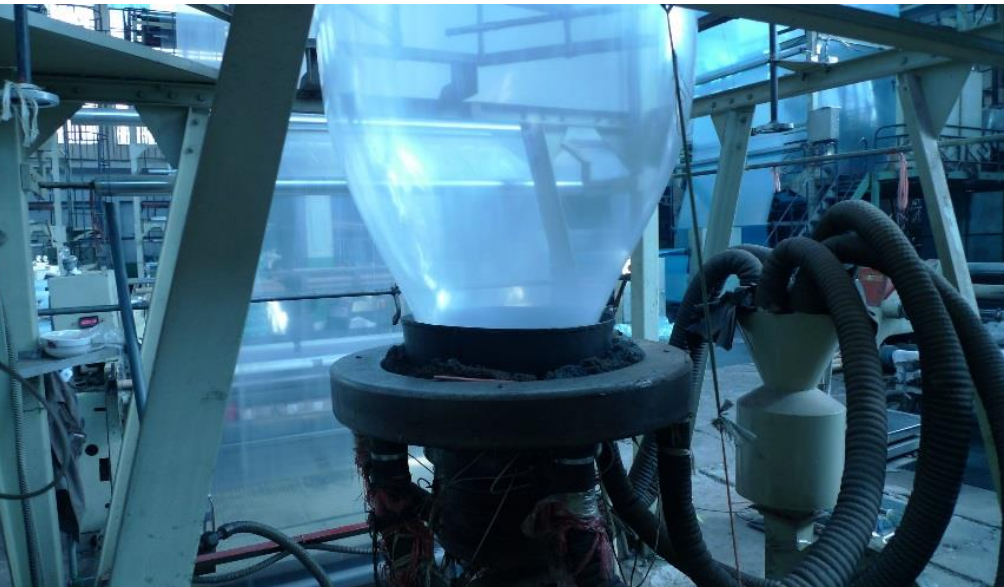


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INTRODUCTION

The **PLASTICS MARKET** is linked to the **CRUDE OIL MARKET** because plastics are primarily petrochemical products that utilize oil and natural gas as major feedstock and fuel (Speight, 2010).

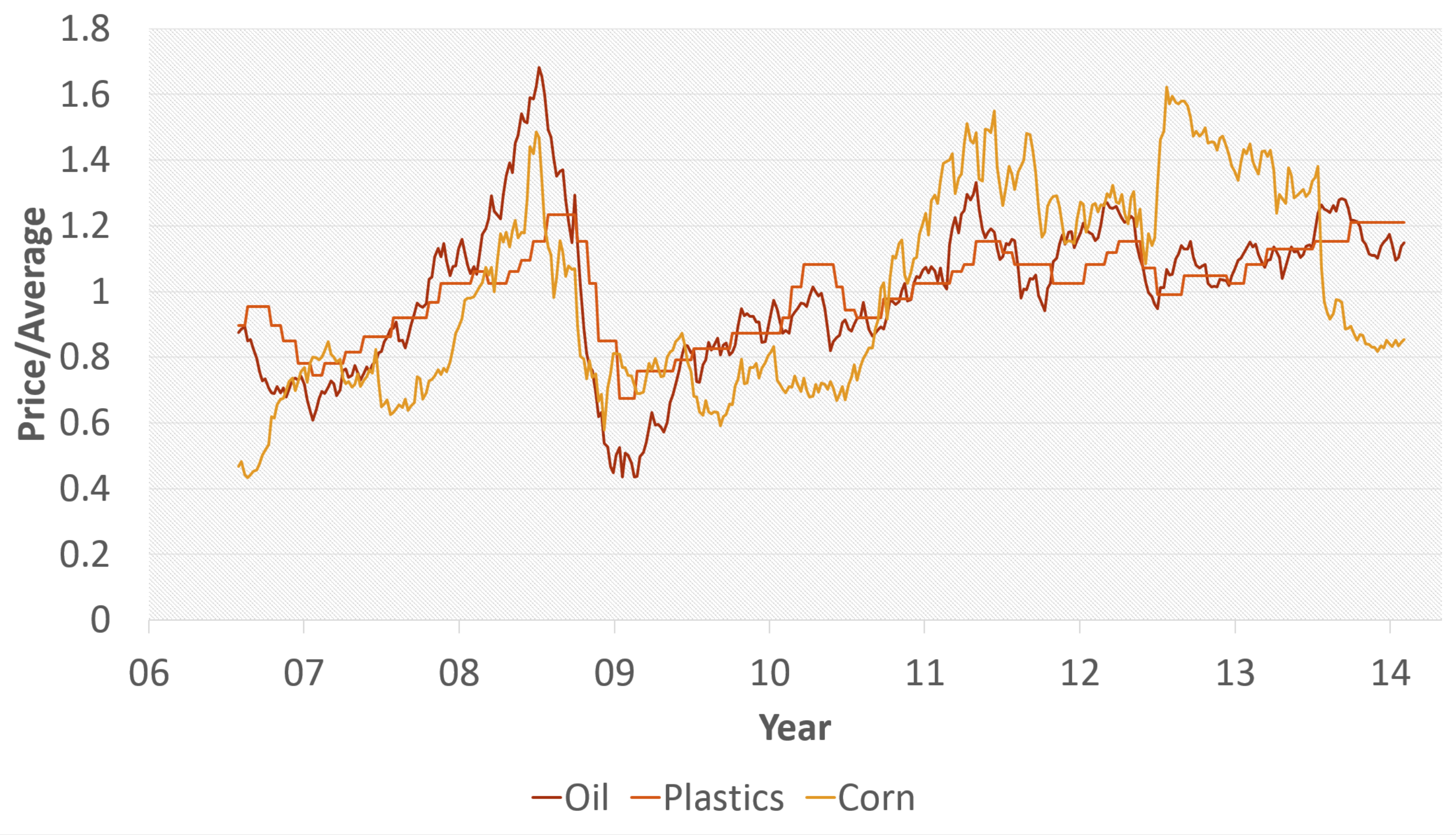


However, recent policy change as well as the rapid expansion of corn-based ethanol production that supports the manufacturing industry in the United States (Tyner, 2008), and the increasing use of starch-based biodegradable plastics due to the increasing concern about oil-based plastic pollution and energy crisis (Begemann, 1997; Vickner, 2013) strengthen links between **THE CORN** and **PLASTICS MARKETS**.

OBJECTIVES

- Investigate the long-term equilibrium relationships between crude oil, corn, and plastic prices in the United States.
- Evaluate the price volatility spillover effects across markets.
- Examine the effect of the Energy Independence and Security Act of 2007 (EISA 2007), which created great opportunities to expand the development of biofuel production in the United States.

DATA



- Weekly data from July, 31st 2006 to February, 6th 2014 (393 observations).
- $P_{O,t}$ is the settlement price of crude oil futures price on the New York Mercantile Exchange (NYMEX).
- $P_{C,t}$ is the settlement price of Corn on the Chicago Board of Trade (CBOT). The weekly plastics price (\$/lb),
- $P_{P,t}$, is the plastic price measured as weekly GP injection molding grade of high-density-polyethylene (HDPE) price.

METHOD

Conditional Mean Model:

Error correction term (Plastics and Corn future long-run relationship)

$$ec_{t-1} = \tau_0 + \tau_C p_{C,t-1} + \tau_P p_{P,t-1}$$

Plastics & Corn Future—VECM

$$\begin{bmatrix} \Delta p_{C,t} \\ \Delta p_{P,t} \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^8 \theta_{CP,i} \Delta p_{P,t-i} \\ \sum_{i=1}^8 \theta_{PP,i} \Delta p_{P,t-i} \end{bmatrix} + \begin{bmatrix} \sum_{i=1}^8 \theta_{CC,i} \Delta p_{C,t-i} \\ \sum_{i=1}^8 \theta_{PC,i} \Delta p_{C,t-i} \end{bmatrix} + \begin{bmatrix} \psi_C ec_{t-1} \\ \psi_P ec_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{C,t} \\ \varepsilon_{P,t} \end{bmatrix}$$

Conditional Variance:

Crude Oil Future

- TGARCH (1,1)

$$\begin{aligned} \Delta p_{O,t} &= \alpha_1 \Delta p_{O,t-1} + \varepsilon_{O,t} \\ \varepsilon_{O,t} | I_{t-1} &\sim N(0, \sigma_t^2) \\ \sigma_t^2 &= \beta_0 + \beta_1 e_{O,t-1}^2 + \beta_2 \sigma_{t-1}^2 + \beta_3 d_t e_{O,t-1}^2 \end{aligned}$$

Corn Future & Plastics

- Constant Spillover Model ARCH (1,1)

$$\begin{bmatrix} \varepsilon_{C,t} \\ \varepsilon_{P,t} \end{bmatrix} = \begin{bmatrix} \omega_{OC} \\ \omega_{OP} \end{bmatrix} e_{O,t} + \begin{bmatrix} e_{C,t} \\ e_{P,t} \end{bmatrix}$$

- Event-Dummy Spillover Model ARCH (1,1)

$$\begin{bmatrix} \varepsilon_{C,t} \\ \varepsilon_{P,t} \end{bmatrix} = \left\{ \begin{bmatrix} \omega_{OC,0} \\ \omega_{OP,0} \end{bmatrix} + \begin{bmatrix} \omega_{OC,1} \\ \omega_{OP,1} \end{bmatrix} D_t \right\} e_{O,t} + \begin{bmatrix} e_{C,t} \\ e_{P,t} \end{bmatrix}$$

Where,

$$\begin{aligned} D_t &= \begin{cases} 1, & \text{Post EISA 2007} \\ 0, & \text{Pre EISA 2007} \end{cases} \\ e_t | I_{t-1} &= \begin{bmatrix} e_{C,t} \\ e_{P,t} \end{bmatrix} | I_{t-1} \sim N(0, H_t) \\ H_t &= \begin{bmatrix} a_{CC} & a_{PC} \\ a_{CP} & a_{PP} \end{bmatrix} + \begin{bmatrix} b_{CC} & b_{CP} \\ b_{PC} & b_{PP} \end{bmatrix}' e_{t-1} e_{t-1}' \begin{bmatrix} b_{CC} & b_{CP} \\ b_{PC} & b_{PP} \end{bmatrix} \end{aligned}$$

Spillover Ratio for Corn ($SR_{C,t}$):

$$SR_{C,t} = \frac{\omega_{OC,t}^2 \sigma_t^2}{h_{CC,t} + \omega_{OC,t}^2 \sigma_t^2}$$

RESULTS & DISCUSSION

The Long-Run Relationship :

$$\begin{aligned} p_{P,t} &= 1.63 + 0.45 p_{C,t} \\ \text{S.D.} &\quad (0.65) \quad (0.13) \end{aligned}$$

The U.S. **PLASTICS** and **CORN FUTURES** prices moved together between Summer 2006 to Spring 2014. When the corn futures prices increase (decreases) by 1cent/ bushel, the plastics price is expected to increase (decrease) by \$0.45/lb.

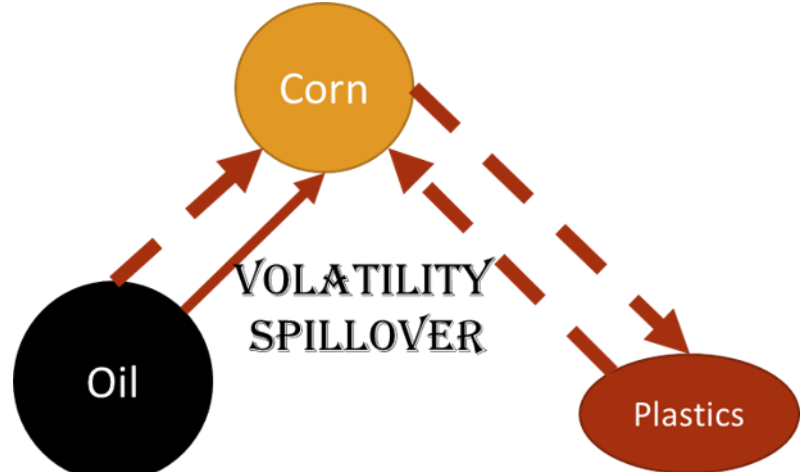
The Short-Run Volatility Spillover:

Constant Spillover Model

Variables	Coefficients
ω_{OC}	0.23***
ω_{OP}	0.03
a_{CC}	0.00***
a_{PP}	0.00***
b_{CC}	0.33***

- The corn futures market **significantly** exhibited an additional risk from the crude oil futures market at 0.05 level.
- The crude oil future market **DOES NOT** significantly transmit volatility to plastics market.
- There is **NO** volatility spillover effects between corn future sand plastics markets.

- Only $\omega_{OC,1}$ is significant at 5% level, which implies that EISA 2007 increased the linkage between the crude oil future markets and corn future markets.



- We also find the significant bidirectional volatility transmission between corn future and plastics markets at the 5% level.

Event-Dummy Spillover Model

Variables	Coefficients
$\omega_{OC,0}$	0.04
$\omega_{OP,0}$	0.01
$\omega_{OC,1}$	0.50**
$\omega_{OP,1}$	-0.01
a_{CC}	0.00***
a_{PP}	0.00***
b_{PC}	0.41**
b_{CP}	0.30***

Statistics Summary for $SR_{C,t}$		
	Constant Spillover Model	Event-Dummy Spillover Model After EISA 2007
Mean	0.03	0.10
Median	0.01	0.04
ST.D.	0.00	0.01
Min	0.00	0.00
Max	0.50	0.77

*significant at 10%, **significant at 5%, ***significant at 1%.

Comparing the Event-Dummy to the Constant spillover model, we find that after implementation of EISA 2007, the risk spillover from crude oil and corn futures markets increased by about **THREE TIMES** the average level, up to 10%. The current spillover ratio is larger than that evaluated after Energy Policy Act of 2005 (Wu et al., 2011).

CONCLUSIONS

- P**lastics prices and corn futures are moving together in the long run, but that the crude oil futures prices are weakly exogenous to this system.
- T**here is an existence of volatility spillover from crude oil futures price to corn futures price, but not from crude oil futures price to plastics price. The development of bioenergy may be driving the current findings.
- T**he bidirectional volatility between corn futures and plastics markets is a new and interesting finding, likely a results of biofuels markets and new biotechnology.
- T**he EISA 2007 has the same effect as the Energy Policy Act of 2005 in increasing the linkage between the corn and the crude oil futures markets. Moreover, the EISA 2007 further induced the new linkages between corn futures and plastics market.

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