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Co-movements of Energy-Bioenergy-Agricultural Commodity
Prices: New Empirical Evidence from the USA

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*Selected Poster prepared for presentation at the
2016 Agricultural & Applied Economics Association Annual Meeting, Boston, MA, July 31- Aug. 2*

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Background

- In the existing literature, there exist two opposing hypotheses on co-movements of energy, bioenergy, and crop prices
- Biofuel caused agricultural feed and agricultural crop prices to become much more connected to energy prices (e.g., Kristoufek et al., 2015).
- The opposite group found that energy and agricultural feedstock prices due to biofuel expansion are not closely connected (e.g., Myers et al., 2014).

Objectives/Research Questions

- Revisit the issue utilizing a newly developed time-series econometric method
- Are the co-movements depend on the time period covered? Whether co-movements are asymmetric?

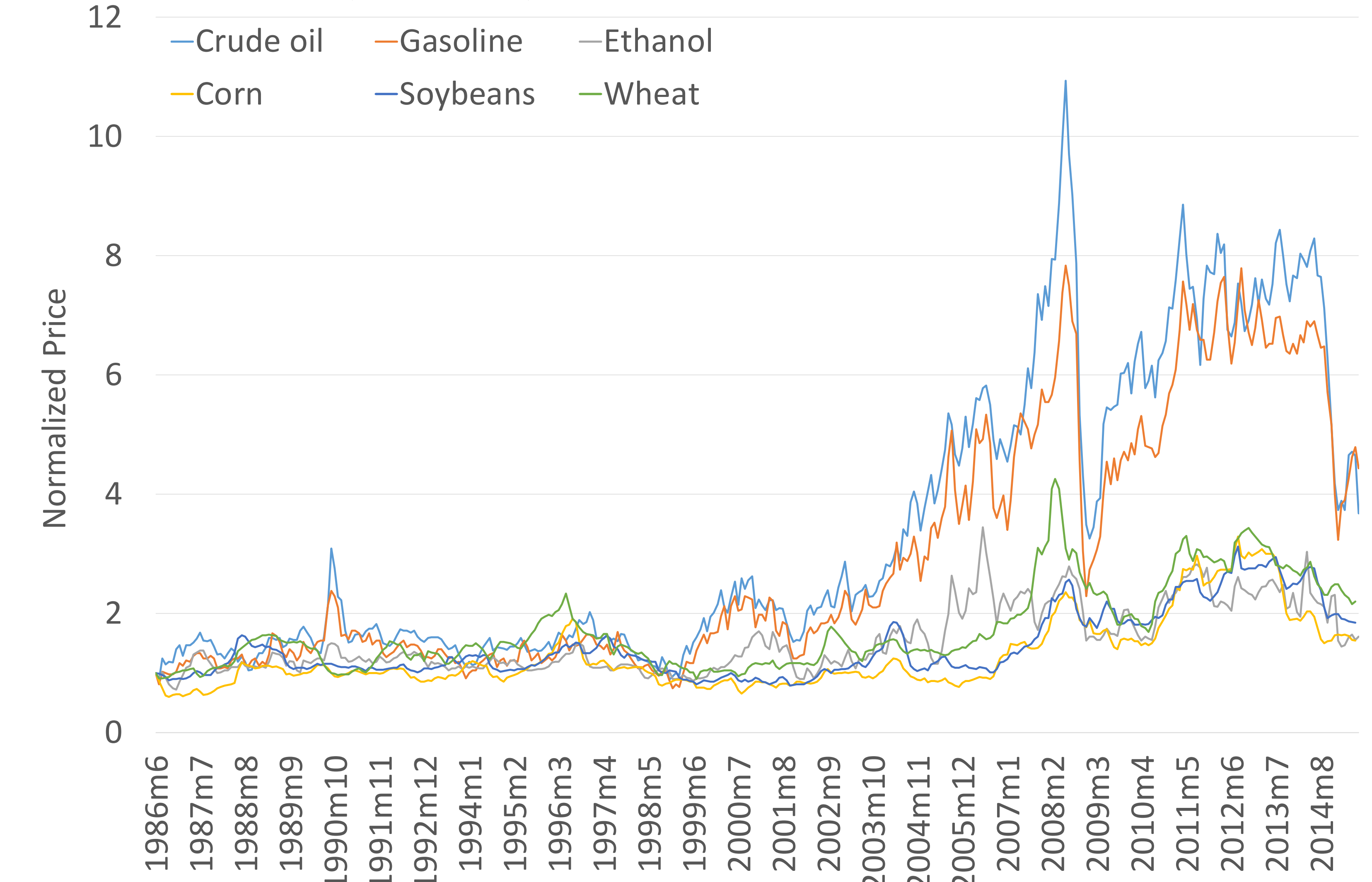
Methods and Data

- Long run equation: (1) $p_{it} = \alpha_i + \beta_i p_{jt} + u_{it}$
- NARDL ECM:
(2) $\Delta p_{it} = \mu_i + \rho_i \xi_{it-1} + \sum_{s=1}^{p-1} \phi_{is} \Delta p_{it-s} + \sum_{s=0}^{q-1} (\pi_{js}^+ \Delta p_{jt-s}^+ + \pi_{js}^- \Delta p_{jt-s}^-) + \varepsilon_{it}$

where i, j denote prices of energy, or bioenergy or crops and $i \neq j$, P is the log prices, (+) and (-) sign denotes partial sum of increases and decreases in prices, respectively.

- Data are from the USDA NASS, U.S. EIA, and Quandl. The data are monthly and the sample period cover from June 1986 to July 2015 (N=351)

Figure 1. Normalized Monthly Crude Oil, Gasoline, Ethanol, Corn, Soybeans, and Wheat Prices (1986m6=1)



Results & Discussion

Table 1. Unit Root Test Results

Log Prices	Test	Level Form		First difference	
		Statistics	p-value	Statistics	p-value
Crude Oil	Dickey-Fuller	-1.75	0.41	-9.67	0.00
	Zivot-Andrews	-3.91		-9.99	
Gasoline	Dickey-Fuller	-1.58	0.495	-10.11	0.00
	Zivot-Andrews	-4.21		-10.45	
Ethanol	Dickey-Fuller	-2.72	0.070	10.54	0.00
	Zivot-Andrews	-6.04		-10.74	
Corn	Dickey-Fuller	-2.22	0.198	-8.55	0.00
	Zivot-Andrews	-4.13		-8.91	
Soybeans	Dickey-Fuller	-1.88	0.342	-8.38	0.00
	Zivot-Andrews	-4.27		-12.20	
Wheat	Dickey-Fuller	-1.97	0.300	-8.60	0.00
	Zivot-Andrews	-4.24		-12.60	

ADF: Critical values: 1% : -3.452, 5% : -2.876 10% : -2.570. lags 3 for all variable. Zivot-Andrews: Critical values: 1%: -5.57 5%: -5.08 10%: -4.82. Maxlags=T^0.25

Table 2: VEC maximum likelihood estimates of Co-integrating vectors on the relationship among energy, bioenergy, and agricultural crop prices in the USA

Co-integrating relationship	Crude oil	Gasoline	Ethanol	Corn	Soybean	Wheat
1	-0.982 (0.00)	1				
2		-0.457 (0.00)	1	-0.75 (0.00)	-0.806 (0.00)	-0.846 (0.00)
3	-0.525 (0.00)			1	-0.92 (0.00)	
4	-0.488 (0.00)				-1.03 (0.00)	1
5	-0.525 (0.00)			1		
6	-0.45 (0.00)		1			

Notes: All variables are in logarithms. Number in parentheses are p-values. All bivariate relationships are estimated using Johansen's maximum likelihood procedure with two/three lagged differences.

From the Tables 1 and 2, this poster finds

- All prices series are nonstationary at the level form except the ethanol price (Table 1)
- Linear cointegrating relationships exist among energy (crude oil, ethanol) and agricultural crop (corn and soybeans) prices [Table 2]
- The pairs corn-soybeans, crude oil-gasoline, and soybeans-wheat are proportional (almost perfect) to each others in the long-run
- The pairs gasoline-ethanol, corn-ethanol, crude oil-ethanol, crude oil-corn, and crude oil-soybeans are partially proportional to each other in the long run.

Table 3. NARDL Estimation Results for Co-movements of energy, bioenergy, and agricultural crop prices in the USA

		Ethanol-Corn	Ethanol-Soybean	Ethanol-Gasoline	Corn-Crude Oil
Asymmetric Coefficients	Long-Run (+)	0.267**	0.297**	0.624***	0.429***
	Long-Run (-)	-0.164	-0.185	-0.657***	-0.429***
	Short-Run (+)	0.363***	0.301***	0.292***	-0.147***
	Short-Run (-)	0.363***	0.301***	0.292***	0.087*
Asymmetric test	F-Stat: Long-Run	10.75	10.66	11.35	Symmetry
	F-Stat: Short-Run	Symmetry	Symmetry	Symmetry	15.8
Nonlinear Cointegration tests	t_BDM	-4.19	-4.17	-7.42	-3.28
	F_PSS	5.88	5.81	20.03	5.39
N		337	337	338	3.37

Notes: *** p<0.01, ** p<0.05, * p<0.10. the 5% critical values of t_BDM and F_PSS are -3.22 and 5.73 respectively with k=1

From the Table 3, this poster finds

- Non-linear cointegrating relationships exist among energy (crude oil, ethanol) and agricultural crops (corn, soybeans) prices
- The co-movement of corn and ethanol prices is not symmetric-ethanol price reacts more to corn price increases than to corn price decreases in the long-run.
- Ethanol price also responds asymmetrically to gasoline price movements but it responds less to an increase of gasoline price than to a decrease in the long run.
- Corn price responds asymmetrically to crude oil price movements in the short-run. It responds less to an increase of gasoline price than to a decrease in the long run.

Conclusions and Policy Implications

- Results of this poster support the hypothesis that the energy and agricultural feedstock prices are closely connected
- Existing debates on whether energy, bioenergy, and crop prices co-move together depend on the methodology we use and/or on the sample period we cover in the analysis.
- This poster's findings will complement and provide further insights on the discussion of "co-movements of energy, bioenergy, and agricultural commodity prices" in the energy-bioenergy-agricultural commodity-nexus literature.

References

- Kristoufek L., K. Janda., and D. Zilberman. 2015. Co-movements of ethanol-related prices: evidence from Brazil and the USA. *GCB Bioenergy*. doi: 10.1111/gcbb.12260
- Myers RJ, Johnson SR, Helmar M, Baumes H (2014) Long-run and short-run comovements in energy prices and the prices of agricultural feedstock for biofuel. *American Journal of Agricultural Economics*, 96, 991–1008.