Do oil prices increase corn price volatility?

Paper presented at the IATRC meeting, Berkeley, California
December 12-14, 2010

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Introduction

Historically, corn prices only to a small extent determined by oil prices:

- via price of modern inputs like fertilizer
- energy used in planting and harvesting
- transportation costs

In recent years additional corn demand used for biofuel production → Did this lead to stronger relation between corn and oil prices?

Introduction

- Tyner and Taheripour (2008): Correlation between corn and oil prices in 1982-2007 is weak (0.16 in levels, -0.11 in first-diffs).
- Tyner and Taheripour (2008): There is a relation between oil and corn prices, but its strength depends on the level of oil prices.
- Abbott et al. (2009): Since 2006 there is a link between crude oil and corn prices in the US.

Introduction

- Besides a potential relation between corn and oil price **levels**, there may also be an effect of oil prices on corn price **variance**.
- But, correlation is not the same as causation (many commodities have similar price spikes).
- Besides, other variables may be important as well, e.g. corn stocks.

Objective: To investigate whether oil prices have a causal effect on corn price levels and variance.

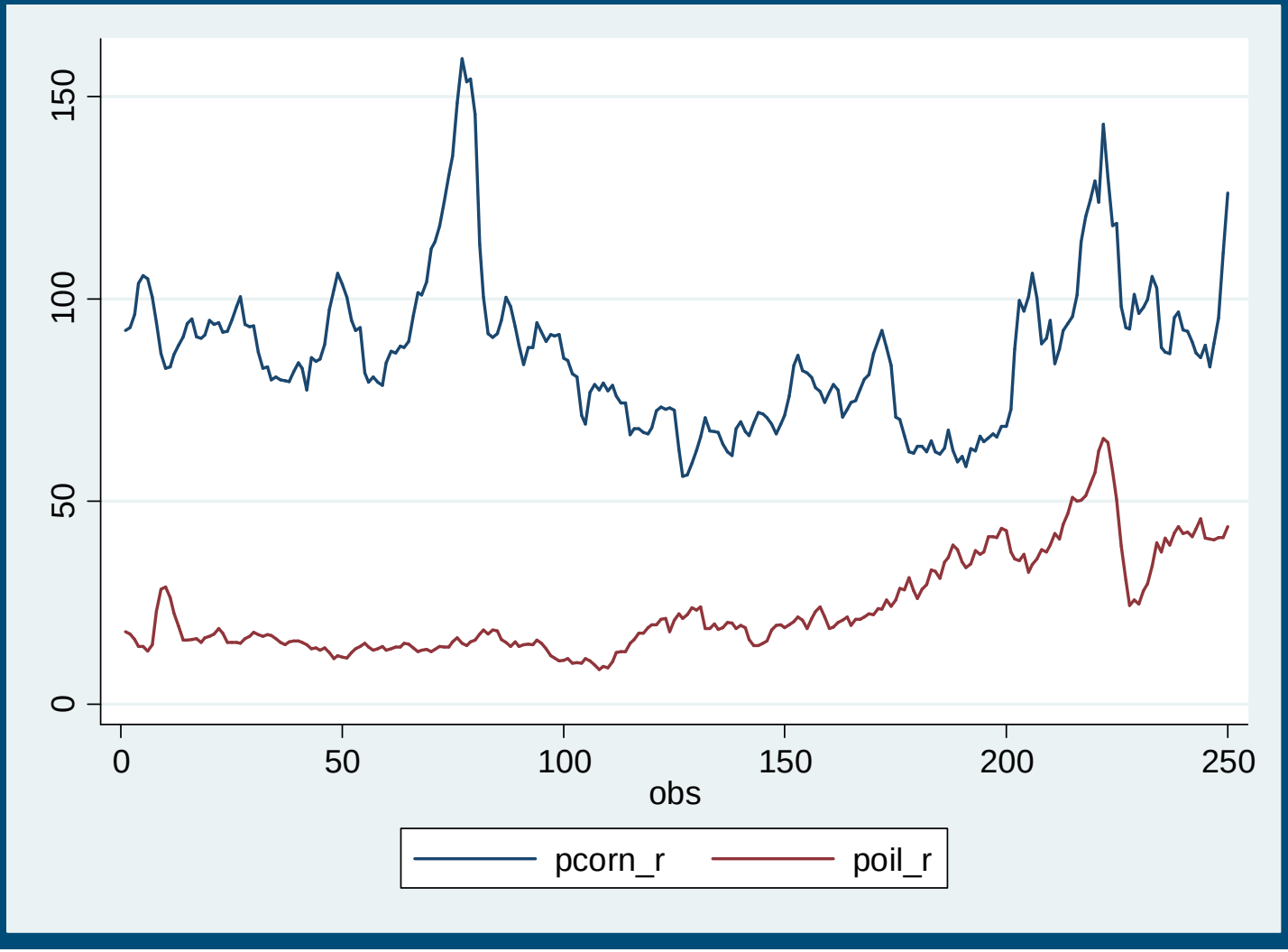
Specific research questions

- Did corn price volatility increase after 2006, the year that the share of corn in biofuels became substantial?
- Are oil prices related to corn prices?
- Is there relation between the oil price and corn price volatility?
- What is the role of corn stocks in determining corn prices and corn price volatility?

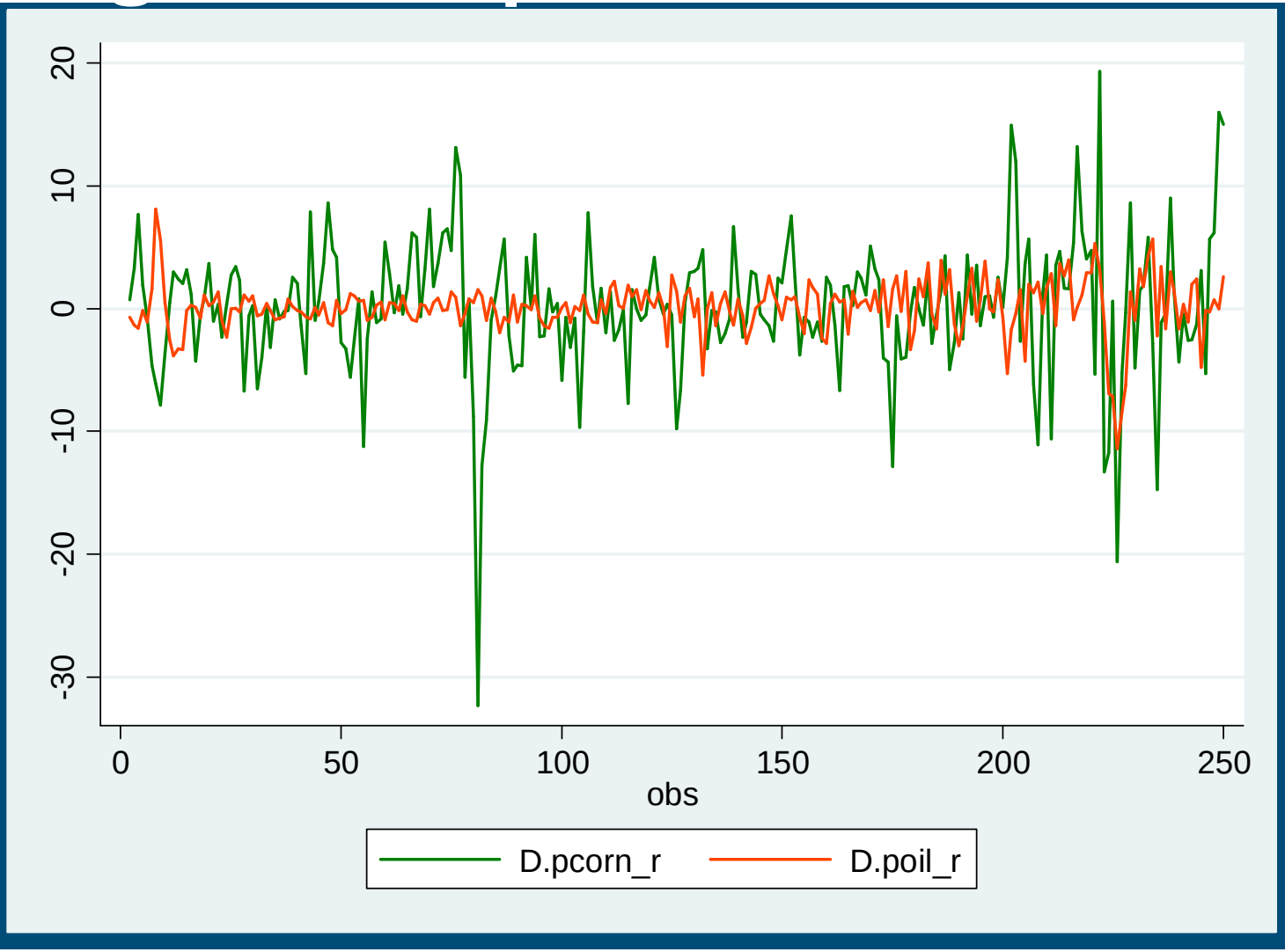
Data

- 250 Monthly obs. January 1990 – October 2010
- Various sources: IMF, US BLS, USDA
- Corn price: USD per ton, variety No.2 Yellow, FOB Gulf of Mexico
- Oil price: USD per barrel, average of Brent, Dubai, and West Texas Intermediate prices
- Corn and oil prices deflated by U.S. PPI
- Quarterly corn stocks in million bushels

Real prices of corn and oil, 1990-2010



Changes in real prices of corn and oil



Coefficients of Variation and Correlation

Period	CV corn	CV oil	Correlation coefficients
1990-1995	0.099	0.213	-0.298
1996-2000	0.287	0.261	-0.199
2001-2005	0.118	0.267	-0.413
2006-2010	0.189	0.211	0.513

Methodology: GARCH model

Simultaneously model means and variance of series:

$$pcorn_t = \alpha_0 + \sum_{k=1}^{K} \alpha_k pcorn_{t-k} + \sum_{l=0}^{L} \beta_l X_{t-l} + \varepsilon_t + \sum_{m=1}^{M} \gamma_m \varepsilon_{t-m}$$

$$h_t = \delta_0 + \sum_{p=1}^{P} \delta_p \varepsilon_{t-p}^2 + \sum_{q=1}^{Q} \varphi_q h_{t-q} + \sum_{r=0}^{R} \lambda_r X_{t-r}$$

where h_t is conditional variance of ε_t.

Methodology: GARCH model

Before GARCH estimation:

- Test stationarity of *pcorn*, *poil*, and *cornstock* using ADF and KPSS tests: *pcorn*, and *poil* I(1), *cornstock* I(0). (Nb. *pcorn* and *poil* not cointegrated)

- Determine best ARIMA structure for *pcorn* (1st equation): ARIMA(0;1;1 3 6) → ε_t white noise

- Test for ARCH effects using LM test
  → $\hat{\varepsilon}_t^2$ significantly related to $\hat{\varepsilon}_{t-1}^2$

Did corn price level and volatility increase?

		Baseline GARCH	GARCH with 2006 dummies
ARMA	Intercept	0.053 (0.385)	-0.138 (0.365)
	ε_{t-1}	0.334 (0.070)***	0.308 (0.077)***
	ε_{t-3}	0.072 (0.063)	0.085 (0.071)
	ε_{t-6}	-0.189 (0.064)***	-0.222 (0.072)***
	Dummy '06-'10		1.342 (1.246)
ARCH	Intercept	5.215 (1.723)***	1.163 (0.611)*
	ε^2_{t-1}	0.318 (0.091)***	0.159 (0.065)**
	h_{t-1}	0.522 (0.126)***	0.662 (0.167)***
	Dummy '06-'10		1.180 (0.283)***

Are oil prices related to corn prices?

		GARCH with different *poil* lags
ARMA	Intercept	-0.004 (0.375)
	$\Delta poil_{t-1}$	-0.222 (0.159)
	$\Delta poil_{t-6}$	0.145 (0.234)
	$\Delta poil_{t-12}$	-0.173 (0.216)
	ε_{t-1}	0.347 (0.078)***
	ε_{t-6}	-0.189 (0.067)***
ARCH	Intercept	1.069 (0.398)***
	$\Delta poil_{t-1}$	0.458 (0.116)***
	$\Delta poil_{t-6}$	-0.016 (0.145)
	$\Delta poil_{t-12}$	0.188 (0.180)
	ε^2_{t-1}	0.197 (0.055)***
	h_{t-1}	0.634 (0.090)***

And what is the role of corn stocks?

		GARCH with $poil_{t-1}$ and $cornstock_t$	GARCH, $poil_{t-1}$ and *dummy '06-'10*
ARMA	Intercept	-0.065 (0.331)	-0.052 (0.351)
	$\Delta poil_{t-1}$	-0.232 (0.152)	
	$\Delta cornstock_{t-1}$	-0.245 (0.114)**	-0.230 (0.146)
	ε_{t-1}	0.327 (0.076)***	0.360 (0.071)***
	ε_{t-6}	-0.184 (0.062)***	-0.191 (0.063)***
ARCH	Intercept	0.282 (0.765)	1.380 (0.388)***
	$\Delta poil_{t-1}$	0.409 (0.138)***	0.147 (0.107)
	$\Delta cornstock_{t-1}$	-0.598 (0.396)	
	Dummy '06-'10		0.952 (0.325)***
	ε^2_{t-1}	0.184 (0.063)***	0.195 (0.069)***
	h_{t-1}	0.702 (0.101)***	0.573 (0.131)***

Conclusions

- There is volatility clustering in corn prices
- Volatility in corn prices is higher in the period 2006-2010 compared to 1990-2005.
- One month lagged oil price has significant effect on corn price volatility, but not on levels...,
- Higher corn stocks reduce corn price, but have no effect on volatility...,
- ...But both effects disappear when we add the simple dummy for 2006-2010.
- → corn price volatilility is higher in 2006-2010 **but not due to oil prices** via biofuels.

Some final thoughts

- Explanations for absence corn-oil price relation.
  - Biofuel policies may stifle market mechanism in biofuel production.
  - Corn prices also determined by other factors, and in other places of the world where biofuels play less relevant role.
- Caveats
  - What is the relevant corn price (frequency, lag used, definition)
  - Are monthly prices representative for market fundamentals (i.e. absence of speculation effects)
  - What is the role of speculation anyway on the corn market?

Thank you

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