**Supply Shocks, Futures Prices, and Trader Positions**

Joseph P. Janzen
Dept of Agricultural Economics and Economics, Montana State University
309A Linfield Hall, P.O. Box 172920
Bozeman, MT 59717-2920, USA
Email: joseph.janzen@montana.edu

Nicolas Merener
Business School, Universidad Torcuato di Tella
1010 Saenz Valiente
Buenos Aires 1428, Argentina
Email: nmerener@utdt.edu

Selected Poster prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28, 2015

# Supply Shocks, Futures Prices, and Trader Positions

Joseph P. Janzen* and Nicolas Merener†
*Department of Agricultural Economics and Economics, Montana State University
†Business School, Universidad Torcuato di Tella

MONTANA STATE UNIVERSITY

UNIVERSIDAD TORCUATO DI TELLA

## Supply Shocks: Rainfall in the U.S. Corn Belt

- Following the adage that "rain makes grain", we exploit the relationship between rainfall and corn production
  - For U.S., most corn production is rainfed; 87-90% of corn acres non-irrigated over 1993-2014
  - Positive correlation between rainfall and corn yield in corn belt is specific to key stages of crop development in June, July, and August (see Tannura, Irwin, and Good, 2008)
  - Rainfall is plausibly exogenous to observed variation in futures prices and trader positions
- Data on daily rainfall at 41 weather stations throughout the corn belt collected from National Climatic Data Center for period from 1993-2014
  - Use production-weighted spatial average across all stations
  - Consider four-day forecast rainfall using actual (future) rainfall as proxy

Figure: Location of weather stations in U.S. corn belt

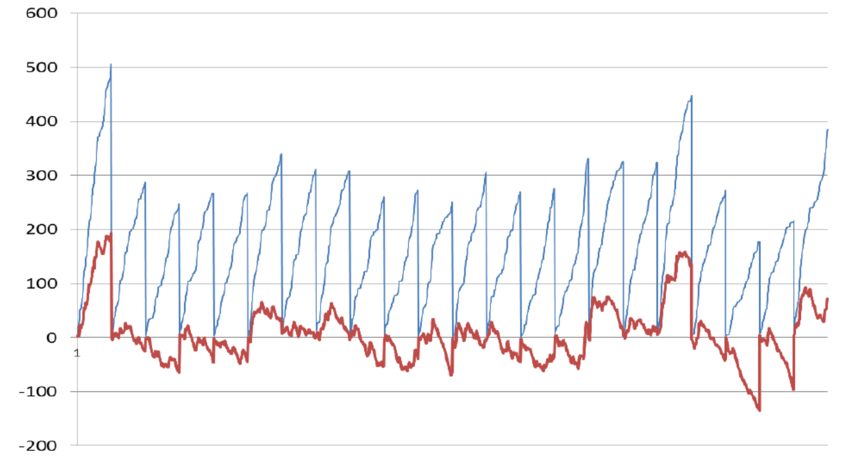

Figure: Accumulated rainfall (blue) and deviation of accumulated rainfall from trend (red) during summer months, measured in millimeters, 1993-2014

- Rainfall variable: cumulative rainfall since June 1 minus linear trend (mean rainfall accumulation to date over 1993-2014)
  - Average rainfall is 3.4mm(0.14in) per day or 309mm(12.3in) per summer
  - Possibility: response of prices and positions is non-linear, depend on whether rainfall is above or below trend

## Futures Prices: CME Corn Futures

- December CME corn futures price is a benchmark for value of new-crop corn
- Physical corn underlying CME futures is deliverable at Illinois River shipping stations at center of corn belt
  - i.e. Corn belt rainfall is an important driver of supply deliverable against December contract

## Trader Positions: CFTC Commitment of Traders

- Commodity Futures Trading Commission publishes weekly snapshot of long and short futures positions held by various groups of traders
  - Two basic groups, commercials and non-commercials, are generally assumed to be hedgers (buy and sell physical corn) and speculators (no physical position)
  - Since 2006, data is available on disaggregate groups (commercial, swaps dealer, managed money, and other reportable)

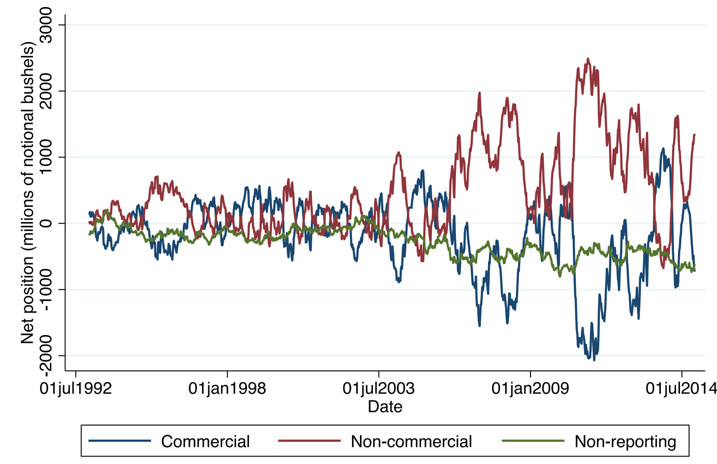


Figure: Net position of trader groups, 1993-2014

## Research Question

***How do prices and trader positions respond to supply shocks in grain futures markets?***

- We know prices fall when supply increases, but the joint response of prices and positions may tell us more:
  - Who has the strongest incentive to trade when supply shifts?
  - Is trading following supply shocks motivated by risk transfer or price discovery?
  - What are the price impacts of various trader groups?

## Analytical Framework and Empirical Model

- Cheng, Kirilenko, and Xiong (2014) (CKX) consider the joint dynamics of futures prices, $F$, and hedger and speculator positions ($x_h$ and $x_s$). In this model:
  - Trader positions each period respond to concurrent shocks to futures prices ($dF$), trading risk as proxied by the VIX market volatility index ($dVIX$), and an "idiosyncratic" shock related to the physical market for the commodity ($dS$).
  - $dS$ may be considered shock to the aggregate physical position held by all traders, that is a supply shock. CKX assume this shock affects hedgers only, but it may also affect speculators if they act on news about fundamentals and contribute to price discovery
  - Both groups may also respond to corn price (implied) volatility shocks ($dIV$) and shocks to external markets, especially crude oil, due to financialization effects or fundamental linkages ($dOil$)
- Therefore, our adaptation of the CKX (2014) model is:

$$(1)\quad dx_h = -\beta_h dF - \gamma_h dVIX - \eta_h dS - \theta_h dIV - \lambda_h dOil$$

$$(2)\quad dx_s = -\beta_s dF - \gamma_s dVIX - \eta_s dS - \theta_s dIV - \lambda_s dOil$$

$$(3)\quad 0 = dx_h + dx_s$$

where (1) and (2) are group demand functions for futures positions driven by structural coefficients ($\beta, \gamma, \eta, \theta$, and $\lambda$) and (3) is a market clearing condition.

- Because $F$, $x_h$, and $x_s$ are jointly determined, (1) and (2) are unidentified. Using (3), we solve for $dF$ and $dx_h$ as a function of the other shocks which may be considered exogenous:

$$(4)\quad dF = -\frac{\gamma_h+\gamma_s}{\beta_h+\beta_s}dVIX - \frac{\eta_h+\eta_s}{\beta_h+\beta_s}dS - \frac{\theta_h+\theta_s}{\beta_h+\beta_s}dIV - \frac{\lambda_h+\lambda_s}{\beta_h+\beta_s}dOil$$

$$(5)\quad dx_h = \frac{\gamma_s\beta_h-\gamma_h\beta_s}{\beta_h+\beta_s}dVIX + \frac{\eta_s\beta_h-\eta_h\beta_s}{\beta_h+\beta_s}dS + \frac{\theta_s\beta_h-\theta_h\beta_s}{\beta_h+\beta_s}dIV - \frac{\lambda_s\beta_h-\lambda_h\beta_s}{\beta_h+\beta_s}dOil$$

- We estimate the linear response of prices and positions to exogenous supply shocks using ordinary least squares (OLS).
- We relate OLS coefficient estimates to structural parameters using (4) and (5)
  - These conditions suggest that price and position responses to exogenous shocks depend on the relative magnitude of the structural coefficients between groups.
  - If (short) hedgers demand for short futures positions is increasing linearly in the size of the aggregate physical position, then $\eta_h > 0$. If hedging demand drives prices and positions, then we expect the coefficient estimate on our supply shock variable to be negative.

## Empirical Results

- We consider separate regressions for prices and positions. We also consider potential non-linear response of prices and positions depending on whether rainfall is above or below trend. (Above trend rainfall indicates that crop-year ending stocks will be large, buffering price response.)

Weekly time series regressions of corn returns ($\Delta \ln F_t$) on accumulated rain, VIX, Oil and momentum, June to August, 1993 to 2014.

$$\Delta lnF_t = \alpha + \beta_1 \Delta AccRain_t + \beta_2 \Delta Vix_t + \beta_3 \Delta Oil_t + \Delta \ln F_{t-1} + \epsilon_t$$

| | All Obs. | Rain < Trend |
|---|---|---|
| $\Delta AccRain_t$ | -0.00046* | -0.0013*** |
| | (0.00025) | (0.0004) |
| $\Delta AccRain_{t-1}$ | -0.00005 | -0.00003 |
| | (0.00026) | (0.00045) |
| $\Delta Vix_t$ | 0.00041 | 0.0001 |
| | (0.0012) | (0.0012) |
| $\Delta Vix_{t-1}$ | 0.00042 | -0.0010 |
| | (0.00012) | (0.0016) |
| $\Delta Oil_t$ | 0.074 | 0.040 |
| | (0.071) | (0.092) |
| $\Delta Oil_{t-1}$ | 0.012 | -0.013 |
| | (0.057) | (0.092) |
| $\Delta F_{t-1}$ | 0.051 | -0.095 |
| | (0.069) | (0.109) |
| Constant | -0.0024 | -0.0011 |
| | (0.0027) | (0.0044) |
| $n$ | 268 | 125 |
| $R^2$ | 0.035 | 0.097 |

Weekly time series regressions of net positions on accumulated rain, VIX, Oil and momentum, June to August, 1993 to 2014.

$$CommNet_t = \alpha + \beta_1 \Delta AccRain_t + \beta_2 \Delta Vix_t + \beta_3 \Delta Oil_t + \Delta \ln F_{t-1} + \epsilon_t$$

$$NonCommNet_t = \alpha + \beta_1 \Delta AccRain_t + \beta_2 \Delta Vix_t + \beta_3 \Delta Oil_t + \Delta \ln F_{t-1} + \epsilon_t$$

| | Commercial | Non-Commercial |
|---|---|---|
| $\Delta AccRain_t$ | 3,554*** | -3,373*** |
| | (785) | (685) |
| $\Delta AccRain_{t-1}$ | -11 | -321 |
| | (1,036) | (970) |
| $\Delta Vix_t$ | 283 | 1,142 |
| | (2,448) | (2,456) |
| $\Delta Vix_{t-1}$ | 2,468 | -311 |
| | (2,758) | (2,556) |
| $\Delta Oil_t$ | 146,333 | -147,496 |
| | (182,613) | (167,515) |
| $\Delta Oil_{t-1}$ | 237,129 | -118,640 |
| | (195,560) | (185,193) |
| $\Delta F_{t-1}$ | -962,238*** | 955,482*** |
| | (233,646) | (217,854) |
| Constant | -14,402 | -20,493** |
| | (9,350) | (8,272) |
| $n$ | 125 | 125 |
| $R^2$ | 0.285 | 0.307 |

### Economic Significance of Coefficient Estimates

- Price impact of one inch of rain: $-0.0013 \times 25.4\frac{mm}{inch} =$ -3.3%
- Position impact of one inch of rain: $3554 \times 25.4\frac{mm}{inch} \times 1000$ bu = 90.2 mil bu.
  - For context, average CME corn futures open interest over 1993-2014 represented 3.7 bil. bu.

### Inference Regarding Structural Parameters

- Coefficient estimates suggest commercials become more long (less short) after positive supply shocks.
- Price response to rainfall suggests that $\eta_s + \eta_h > 0$
- Position response to rainfall suggests that $\eta_s > \eta_h$ (assuming $\beta_s \approx \beta_h$)
- These results are inconsistent with "hedging pressure" theory of commodity futures trading. Hedgers may not increase size of hedge when crop gets larger.

## References

Cheng, I.H., A. Kirilenko, and W. Xiong. 2014. "Convective Risk Flows in Commodity Futures Markets." *Review of Finance*, 1-49 .
Tannura, M.A., S.H. Irwin, and D.L. Good. 2008. "Weather, technology, and corn and soybean yields in the US corn belt." Marketing and Outlook Research Report No. 2008-01, University of Illinois at Urbana- Champaign, February.



Contact: joseph.janzen@montana.edu or nmerener@utdt.edu