Permanent and Temporary Shocks in Corn and Soybean Basis Series

: A New Approach for Modeling Time-Series

Yoonsuk Lee
Aquaculture/Fisheries Center
University of Arkansas at Pine Bluff
Pine Bluff, 71601
Phone: 870-575-9809
Fax: 807-575-4637
Email: keynes833@hotmail.com

B. Wade Brorsen
Department of Agricultural Economics
Oklahoma State University
Stillwater, OK 74078
Phone: 405-744-6836
Fax: 405-744-8210
Email: wade.brorsen@okstate.edu

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Yoonsuk Lee and B. Wade Brorsen
Department of Agricultural Economics, Oklahoma State University

Introduction

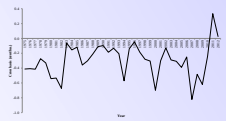
• Various time-series models have attempted to explain features of time-series data caused by irregular events.

• Such irregular events are distinguished between permanent and temporary shocks in this study.

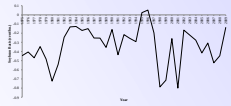
• This study develops a new stochastic time-series model that imposes different distributions into permanent and temporary shocks, respectively.

• Corn basis and soybean basis series are selected as primary examples of realistic time-series data

Illinois Corn for Harvest Basis from 1975 to 2012



Illinois Soybean for Harvest Basis from 1975 to 2009



Objectives

➢ Propose a single stochastic process to include permanent and temporary shocks:
- Permanent shocks are reflected by a Bernoulli-jump process
- Temporary shocks are explained by an independent and identically distributed normal distribution

➢ Determine whether the proposed model is well calibrated through the indirect inference of comparing with ARIAM models with outliers.

Contact Yoonsuk : keynes833@hotmail.com
Dr. Brorsen: wade.brorsen@okstate.edu

Model Development

Bernoulli-jump Model

The data generating process mixed with a Bernoulli process is expressed as:

$$Series_t = \alpha_t + e_t,$$
$$\alpha_t = \alpha_{t-1} + \beta + B_t J_t,$$
$$\Delta series_t = series_t - series_{t-1} = \beta + B_t J_t + e_t - e_{t-1}.$$

where $Series_t$ is a series at time t, α_t is an observed variable which assumed to explain a permanent shock occurring in a given time t , e_t are the temporary shocks and follows an i.i.d N(0, σ_e^2), $E(e_t e_{t-1}) = 0$, β is a drift, J_t follows i.i.d N(μ_B, σ_B^2), B_t represents one permanent shock and follows a Bernoulli (P) process, P is the probability of one permanent shock and B_t and J_t are independent.

ARIMA with outliers (Competing model)

Based on the outlier specification of Tsay (1988), the ARIMA with outliers model can be written as:

$$Z_t = w_0 \cdot \frac{\Phi(L)}{\Theta(L)} \cdot \zeta_t^{(D)} + Y_t,$$

where Z_t is a series contaminated by outliers at time t, $\frac{\Phi(L)}{\Theta(L)}$ represents the characteristics of outliers, $\zeta_t^{(D)}$ is dummy variable for outliers occurring at time point D, $\zeta_t^{(D)} = 1$ if $t=D$ and $\zeta_t^{(D)}=0$ if $t \neq D$.

Procedures

Bernoulli-jump Model

➢Gallant and Tauchen's (1996) approach for the GMM estimation to estimate the proposed model

➢Take a first order condition of the assumed log-likelihood function of the proposed model with respect to parameters

➢Each f.o.c becomes a moment condition for the GMM estimation

➢In order to handle autocorrelation in the series, add an additional moment condition about autocorrelation

Reference
Gallant, A.R., and G.E. Tauchen. 1996. "Which Moments to Match?" *Econometric Theory* 12:657-681
Tsay, R.S. 1988. "Outlier, Level Shifts, and Variance Changes in Time Series." *Journal of Forecasting* 7:1-20

Results

Bernoulli-jump Model

• Find most shocks are related with permanent shocks in corn and soybean basis series.

Parameter Estimates from the Proposed Model

Parameters	Corn Basis	Soybean Basis
	GMM with Autocorrelation	GMM with Autocorrelation
Drift	-0.0392 (0.0441)	-0.0103 (0.0471)
Jump mean	0.0927 (0.1120)	0.0287 (0.0847)
Variance	0.0057 (0.0041)	0.0032 (0.0052)
Jump variance	0.0854 (0.0147)	0.0742 (0.0258)
Probability of jump	0.5247 (0.0991)	0.6857 (0.2085)

Note: numbers in parenthesis are standard errors.

ARIMA with outliers

• Find a transient change outliers around 2010 in corn basis and there is no outlier in soybean basis.

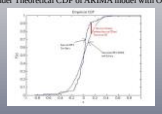
Parameter Estimates form ARIMA with Outliers

Parameters	Estimates	P-value	Years	Types
Corn basis (ARIMA (0,1,1) with LS and TS				
MA(1)	0.769	<.0001		
Outlier1	0.505	0.0002	2010	Transient Change
Soybean basis (ARIMA (0,1,1) with LS and TS)				
MA(1)	0.810	<.0001		
No outlier				

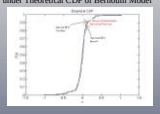
Calibration Tests

➢ For the indirect inference of a better fit to data, an empirical distribution function statistics are used.
➢ The proposed Bernoulli-jump model reflect the feature of corn and soybean basis series, reasonably well.

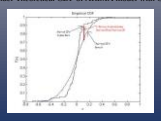
K-S Test of Empirical CDF of Corn Basis under Theoretical CDF of ARIMA model with Outliers



K-S Test of Empirical CDF of Corn Basis under Theoretical CDF of Bernoulli Model



K-S Test of Empirical CDF of Soybean Basis under Theoretical CDF of ARIMA model with Outliers



K-S Test of Empirical CDF of Soybean Basis under Theoretical CDF of Bernoulli Model