The Information Content of the Limit Order Book

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Introduction

- Agricultural commodity futures were traditionally traded in the open outcry pit, however, over the past decade there has been a major shift to trading on the electronic platform. Today the Chicago Mercantile Exchange (CME) Group, the largest futures contracts open interest exchange, has completely migrated its agricultural futures trading to the electronic platform.
- One major difference between pit and electronic trading is the presence of the **limit order book (LOB)** in the electronic system. The LOB contains actual bid and ask prices and their corresponding volumes at different levels. The difference between the lowest ask and the highest bid is referred to as "the spread" or **bid-ask spread (BAS)**. The other bids and asks are resting in descending and ascending order beyond the best bid and best ask, respectively, in the LOB.
  - Grain traders have access to 9 levels beyond the best BAS.
  - Livestock traders have access to 4 levels beyond the best BAS.

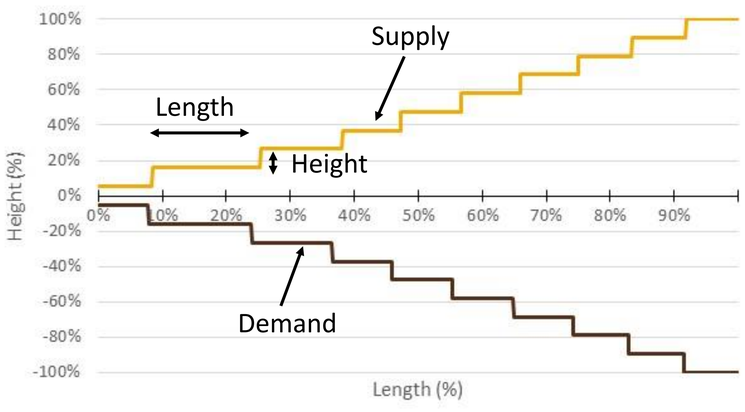
Objective

- To assess the informational content of the LOB beyond the best bid and ask quotes in agricultural futures markets. We reconstruct the full LOB and compute both the BAS at the best quotes and the bid and ask at subsequent levels of the LOB beyond the best quotes. The informational content of the order book is then assessed by estimating the contribution of each of these series to price discovery.
- A better understanding of the contribution of the LOB to the fundamental price may play a crucial role in developing their trading algorithms and strategies.

Methods

Price levels beyond the best BAS:

- The market demand (supply) step function is the relationship between each bid (ask) price level *n* and its associated number of contracts, aggregated across all orders.
  - Height of step i is the difference between price i (P_i) and price $i-1$. For example, the height of step 3 on the demand side is the difference between the third best bid and the fourth best bid.
  - Length of step i is the summation of the contracts (Q_i) across all orders for price i on each demand or supply side.



Wheat average LOB; Nov. 23, 2015 – Mar. 31, 2016

- Weighted price (*WP*): heights and lengths of the demand and supply step functions normalized using the summation of all heights and all lengths (Cao et al. 2009).

$$WP^{n_1-n_2} = \frac{\sum_{i=n_1}^{n_2}(Q_i^b P_i^b + Q_i^a P_i^a)}{\sum_{i=n_1}^{n_2}(Q_i^b + Q_i^a)}, n_1 \leq n_2$$

where n_1 and n_2 are two different levels of the LOB and *a* and *b* denote ask and bid respectively

- Mid best BAS (*MID*), the mean of the best bid and ask, is used to compute the first step heights for both supply and demand sides.

Methods (cont'd)

Model

All *j* price series of an underlying commodity are cointegrated, where *j* = transaction price (*TP*), *MID*, and *WP*. We estimate a vector error correction (VEC) model of the form:

$$\Delta y_t = \Pi y_{t-1} + \sum_{k=1}^{K-1} \Gamma_k \Delta y_{t-k} + \varepsilon_t$$

where Δy_t is a vector of the differenced *j* price series, Π and Γ_k are matrices of coefficients, and ε_t is a vector of residuals. Using the vector autoregressive (VAR) representation of the VEC model (Lütkepohl 2005) and Beveridge and Nelson's (1981) decomposition the model can be written as:

$$y_t = y_0 + \Psi(1)\sum_{i=1}^{t}\varepsilon_i + \Psi^*(L)\varepsilon_t$$

where $\Psi(1)$ is the matrix of long-run coefficients with elements ψ_j, $\Psi^*(L)$ is the matrix of transitory shocks, and ε_t are residuals with variance-covariance matrix Ω with elements σ_j.

Information share measures

- Hasbrouck (1995) Information Share:

$$IS_j = \frac{(\psi_j \sigma_j)^2}{\psi \Omega \psi'}$$

- Gonzalo and Granger (1995) Permanent-Transitory Component:

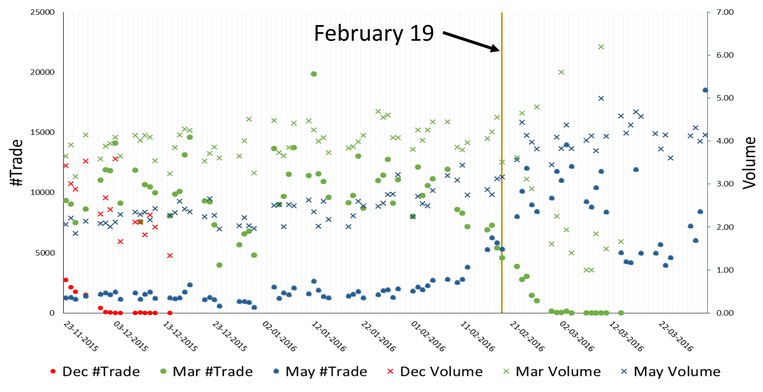
$$PT_j = \frac{\psi_j}{\sum_{j=1}^{k}\psi_j}$$

- Lien and Shrestha (2009) Modified Information Share:

$$MIS_j = \frac{[\psi F]_j^{\,2}}{[\psi F]\Omega[\psi F]'}$$

Data

- The study is performed using nearby contracts for five major agricultural commodities, namely soybeans, corn, wheat, live cattle, and lean hogs, as well as the popular E-mini S&P 500 from the CME Group.
- Sample period: Nov. 23, 2015 – Mar. 31, 2016 .
- We use all the market messages containing all the information necessary to recreate the LOB, such as bids, asks, transaction prices, and quantities time stamped at nanosecond precision.
- Futures contracts are rolled over when the number of trades and volume in the new contracts are greater than in the current contract. For example, in the figure below, the March 2016 contract is rolled over to the May 2016 contract on February 19.



Wheat Nearby Contracts; Nov. 23, 2015 – Mar. 31, 2016

Results

- Overall, the three measures indicate a strong contribution to price discovery of over 30% for WP for all agricultural commodities
- The information contained in the WP is greater for agricultural commodities than for thef E-mini S&P 500.
- Across agricultural commodities, the informativeness of WP for the group of grains is higher than that for the meats group.

Results (cont'd)

- Except for corn, MID seems to have a higher share than WP. For corn, however, two of the three measures result in higher contribution to price discovery for WP than MID.
- Lve cattle levels closer to BAS have relatively more information share based on the three metrics results.
- For grains, the measures suggest that the two levels beyond BAS are as informative as the seven levels further away.

Information Share Measures (%)

		IS_M	PT	MIS
Lean Hogs	Price	44.42	23.76	27.36
	MID	36.42	44.55	38.55
	WP25	32.80	31.69	34.27
Live Cattle	Price	41.02	17.24	23.59
	MID	42.28	51.40	41.43
	WP25	32.58	31.36	34.98
Corn	Price	26.11	12.26	15.95
	MID	48.32	39.71	40.81
	WP210	33.46	48.02	43.24
Wheat	Price	36.43	20.30	22.35
	MID	40.10	41.45	38.38
	WP210	35.23	38.25	39.27
Soybeans	Price	32.39	14.87	17.78
	MID	45.10	45.63	41.50
	WP210	35.90	39.50	40.72
E-mini S&P	Price	27.58	11.34	14.42
	MID	57.01	61.96	45.87
	WP210	29.04	26.70	39.34

Conclusions

- Our study indicates a significant role for the LOB levels beyond BAS to the price discovery of agricultural commodities.
- The results suggest that the contribution of the LOB beyond BAS to price discovery is greater for agricultural commodities than for the stock market.
- Our results also show that the faked and spoofing market orders are less present in the agricultural futures markets than in the stock market.

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