Estimating the Cost of Liquidity in Livestock Futures Markets using the Information Contained in the Limit Order Book

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Picture taken by Christine Rawluk

Background

❖ Agricultural commodity futures trading has shifted over the past decade from the open outcry pit to the electronic platform.

❖ A major difference between trading systems is the presence of the **limit order book (LOB)** in the electronic system, which contains actual bid and ask prices and their corresponding volumes at different levels.

❖ Market microstructure research in agricultural commodity markets has been limited to the study of the best bid and best ask prices in the open outcry pit. However, commodity traders may be interested in ask and bid prices and volumes beyond these best levels. For example, a trader submitting a large order may incur higher transaction costs if their order is not fully executed at the best prices due to insufficient volume at this level and if subsequent prices are far from the best ones.

❖ Currently there are no livestock futures contracts trading in Canadian futures exchanges, making the Chicago Mercantile Exchange (CME) Group livestock futures the most commonly used.

❖ Knowledge of the behavior of the cost of liquidity is of value to market participants to develop marketing strategies aiming at managing their liquidity risk.

Daily volume of live cattle contracts traded electronically and in the pit, 2007 - 2012
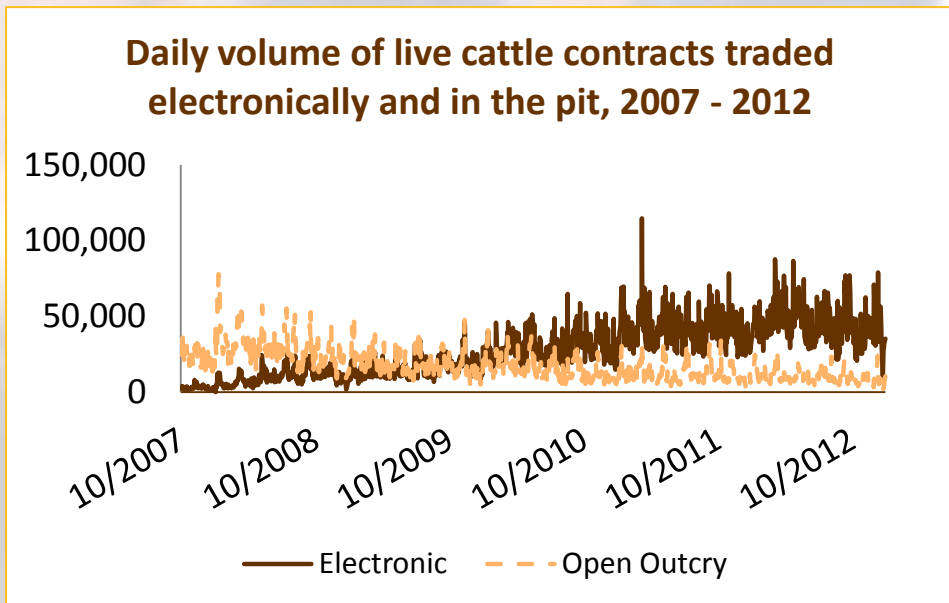
Source: Bloomberg

A Limit Order Book for Live Cattle Futures Contracts
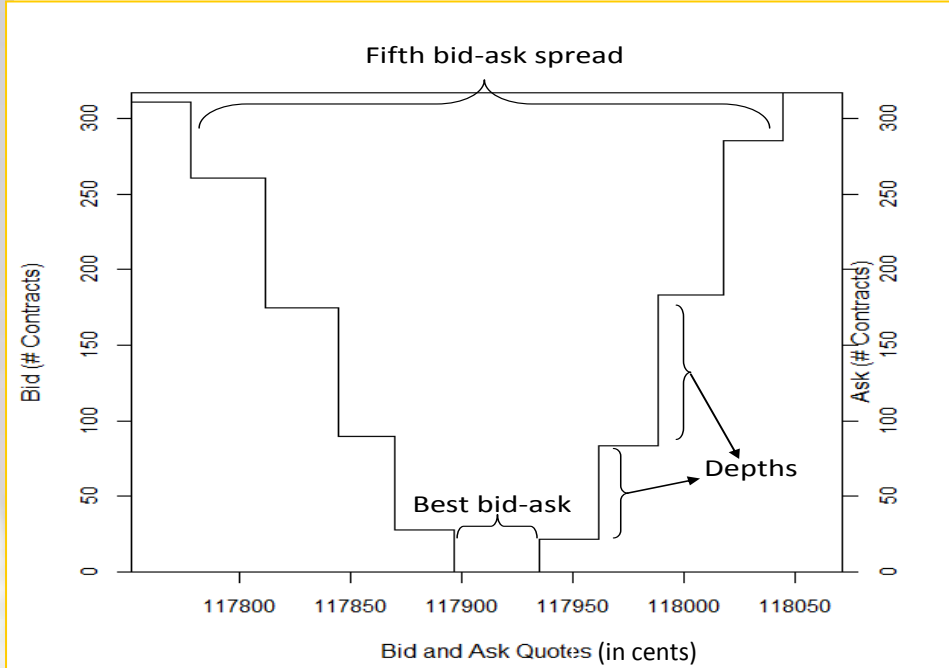
Objectives

❖ Investigate the information contained in the slope of the order book. The slope summarizes the depth dimension of liquidity and has been little explored in agricultural commodities.

❖ Examine the impact of liquidity shocks on the observed best prices and on the slope of the book, focusing on the speed at which they recover after the shock.

Data

❖ We use the *Market Depth* dataset from the Chicago Mercantile Exchange (CME) containing all market data messages required to recreate the book for live cattle December futures traded electronically between July and November 2012 (66 trading days). The recreated LOB is 5-levels deep.

❖ A trading period from 9 a.m. to 5:00 p.m. was analyzed for each trading day, with a snapshot of the LOB constructed at every 30 minute interval (16 intervals/day). Each variable had a total of 1056 observations.

Data *(contd.)*

Variables	Mean	Min	Max	Standard Deviation	Description
Spr_BA (ticks)	4.60	24	62	7.06	Best bid-ask spread.
ADM1 (cents)	4381874	124675	411000000	190000000	Monetized depth at the best ask.
BDM1 (cents)	3664468	124550	138000000	10300000	Monetized depth at the best bid.
Spr_A15 (ticks)	12.73	4	54	18.88	Difference between best and fifth ask.
Spr_B15 (ticks)	13.50	1	60	9.11	Absolute difference between best and fifth bid.
ADM25 (cents)	146000000	1759525	622000000	382000000	Cumulative depth available at the second until fifth ask.
BDM25 (cents)	103000000	1758325	2830000000	76600000	Cumulative depth available at the second until fifth bid.
*Slope A	67597	2486240	4374171	237581	Slope of the book at the ask.
*Slope B	-16575	-2132917	892435	145824	Slope of the book at the bid.

*The slope of the book can be interpreted as the elasticity of supply or demand.

Methods

❖ Dynamic behavior of spreads and depths at and beyond the best limits and their interrelation are investigated using vector autoregression (VAR) models and impulse response framework (Wuyts 2009).

❖ In the VAR specification, all endogenous variables are modeled as a system, where the evolution of each variable is explained by its own lags and the lags of all the other variables in the model. The impulse response functions over time show the behavior of each variable when shocks of other variables enter into the system (Lutkepohl 2005).

Model 1: Limit Order Book Slopes

$$y_t = \{Spr\_BA_t, Slope\ A_t, Slope\ B_t\}$$

❖ Using the methodology utilized by Wuyts (2009), the average elasticity (slope) for the five first limit prices at the ask side of the market is computed as follows:

$$Slope\ A = \frac{1}{5}\left[\frac{\frac{ADC1_t}{AP1_t}}{\frac{M_t}{1}-1} + \frac{ADC2_t - ADC1_t}{\frac{ADC1_t}{AP2_t - AP1_t}} + \cdots\cdots + \frac{ADC5_t - ADC4_t}{\frac{ADC4_t}{AP5_t - AP4_t}} \right]$$

Where M_t is the midprice defined as the average of the best bid and ask price. Slope B (bid) is computed using a symmetric procedure with absolute values of the price differences in the denominator utilized.

Model 2: Prices and Depths in the Limit Order Book

❖ Although limit order books offer the advantages of a concise model, it is however not possible to distinguish dynamics at the prices or depth. We therefore, develop a second model allowing for this by taking into account both the difference between subsequent prices at bid and ask sides and depths, and specify the vector of endogenous variables in model 2 as:
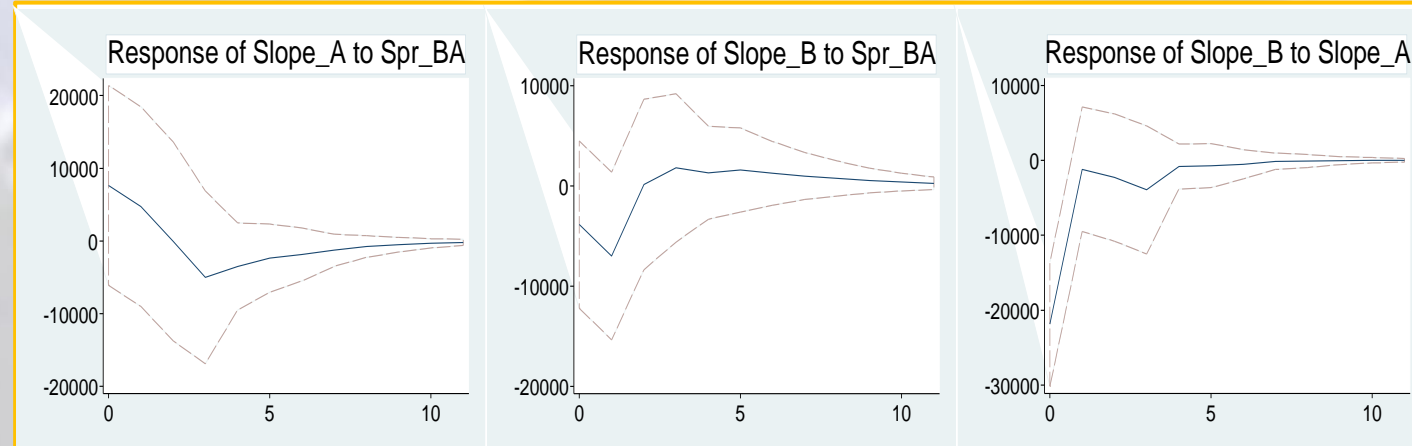
$$y_t = \{Spr\_BA_t, ADM1_t, BDM1_t, Spr\_A15_t, Spr\_B15_t, ADM25_t, BDM25_t\}$$
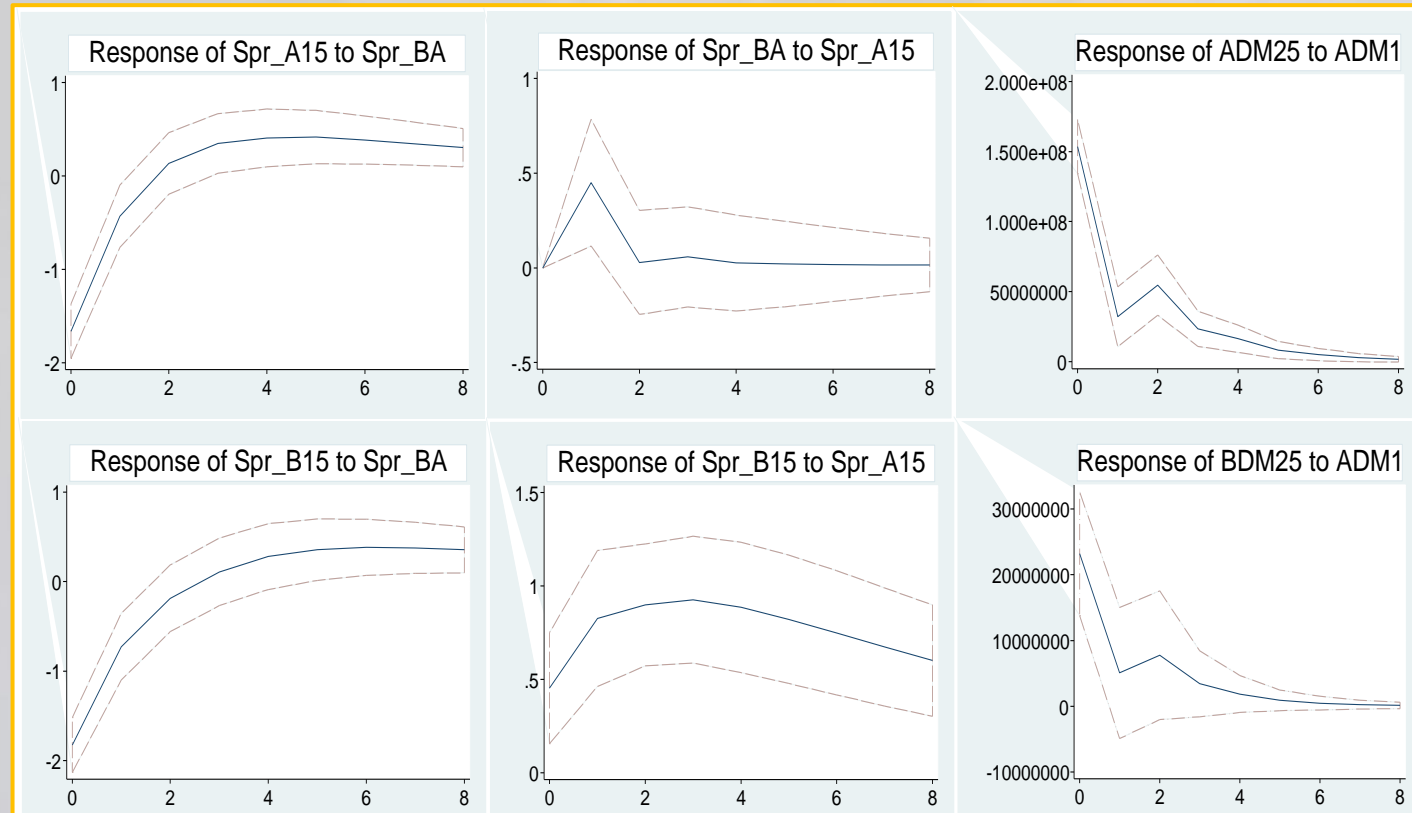
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Results

Model 1 – Impulse response functions

Model 2 – Impulse response functions

The graphs show the impulse responses to a one standard deviation increase in the impulse (shock) variable. The horizontal axis show future time periods, and the dotted lines represent 95% confidence intervals.

❖ There is little evidence of a relation between the bid-ask spread and the slopes for both bid and ask sides.

❖ The slope of the book at the bid side shows an initial decrease to a positive shock of a one standard deviation increase in the slope at the ask side which dies out after 30 minutes and vice versa.

❖ The inside spreads (Spr_A15 & Spr_B15) first react negatively to a one standard deviation increase in the spread at the best prices (Spr_BA).

❖ A shock to the inside spread on the ask side (Spr_A15) results in an increase in the bid-ask spread which declines after one period. A shock to Spr_B15 has a similar impact on Spr_A15.

❖ A positive shock to depth at the best ask (ADM1) causes the depth further down the book on both sides of the market (ADM25 & BDM25) to increase.

Conclusions

❖ A relation exists between the best limits and liquidity beyond in the limit order book. If liquidity at the best limits decline, so does liquidity in the book.

❖ Some measures of liquidity co-move. If the inside spread on one side of the book increases after a shock, the spread at the best prices and inside spread on the opposite side of the market also increase.

❖ A shock is not limited to the side of the market at which it occurs. A shock that increased liquidity at the bid side was seen to also decrease liquidity on the ask side.

❖ Results are in line with the findings in Wuyts (2009) for the Spanish Stock Exchange, although the impact of a shock in liquidity takes longer to be realized in the live cattle market.

References

Lütkepohl, H. 2005. *"New Introduction to Multiple Time Series Analysis."* Berlin: Springer-Verlag.

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Acknowledgments