NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

Is Pit Closure Costly for Customers? A Case of Livestock Futures

by

Eleni Gousgounis and Esen Onur

Suggested citation format:

Gousgounis, E., and E. Onur. 2017. "Is Pit Closure Costly for Customers? A Case of Livestock Futures." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

Is Pit Closure Costly for Customers?

A Case of Livestock Futures

Eleni Gousgounis and Esen Onur*

Preliminary and Incomplete

ABSTRACT

Motivated by CME's decision to close down most of the futures pits in July of 2015, we analyze the changes in the livestock futures market between 2014 and 2016. The livestock futures market, which had an active presence at the pit prior to the closure, has recently exhibited unprecedented price fluctuations. A simultaneous increase in the bid ask spread has raised concerns over the availability or liquidity in this market. The focus of our study is to analyze whether liquidity has changed for customer orders after the futures pit closed. In more detail, we track customer orders and evaluate their execution quality. We investigate whether execution costs for such trades have increased after the futures pits closed. In addition, we also examine whether customers have changed their trading behavior by placing more aggressive orders.

*Eleni Gousgounis is an Assistant Professor at Stevens Institute of Technology and Esen Onur is an Economist at the U.S. Commodity Futures Trading Commission. The paper was co-authored by Eleni Gousgounis and Esen Onur. According to information provided by the Office of the Executive Director and the Procurement Office, Ms. Gousgounis, who is an Assistant Professor at Stevens Institute of Technology, is a CFTC employee with the position title of Consultant. Mr. Onur is a CFTC employee with the position title of Economist, CFTC Office of the Chief Economist. Ms. Gousgounis and Mr. Onur wrote this paper in their official capacity, and as part of their official duties. According to supporting documents, the authors performed data analysis during periods when they were officially under CFTC affiliation. As a result, each author had authorized access to data. As federal employees, Ms. Gousgounis and Mr. Onur are subject to ethics regulations and other agency-specific and government-wide laws and regulations for federal employees. Ms. Gousgounis did not receive any compensation for this paper. Mr. Onur did not receive compensation for this paper other than his CFTC compensation for performing his duties as a CFTC employee.

1. Introduction

In July of 2015, the Chicago Mercantile Exchange (CME) decided to close down most of its pits, getting rid of floor trading in almost all of its markets. While this decision probably made sense from the CME's business perspective, it also caused a lot of discussion on whether the CME was getting rid of a trading design that actually had value for customers and market participants[1]. While the goals of an exchange and its participants are not orthogonal, they are not parallel either. Exchanges naturally want to increase the volume executed on their platforms while participants potentially care more about execution costs. Motivated with this idea, we explore how execution costs have changed for customers at the livestock futures markets traded at the CME after the pits were closed.

Livestock futures are made up of three markets; live cattle futures, lean hog futures, and feeder cattle futures. Live cattle futures has the highest amount of trading among them, while feeder cattle futures has the lowest[2]. Additionally, live cattle futures also has experienced high levels of volatility recently, as seen in Shang, Mallory, and Garcia (2016).

While the claims of increased volatility seem to have some truth in them, it is hard to pin point the exact reason for it. The market has seen a number of changes in the last few years. We know that the ratio of pit transactions to electronic has been dwindling in the previous years (Gousgounis, Onur 2016). In the mid-December of 2014, CME has decided to change the settlement procedure in the livestock futures. Prior to that date, settlement was based on the volume weighted calculation of pit transactions only. After that date, settlement price was calculated using pit as well as electronic transactions in the calculation. This has diminished the importance of pit transactions[3]. Following the change in settlement procedure, and in line with the change in almost all of CME's markets, livestock futures pits have closed on July 6th, 2015. Since then, hedgers in these markets have claimed that volatility has increased without much of an explanation, even causing The Wall Street Journal to refer to this market as a "Meat Casino"[4].

This is not the first study to analyze the effect of pit closure on markets. Gousgounis and Onur (2016) analyze the impact of this change on various markets and show which ones were affected more than others. Based on that analysis, it is clear that livestock futures, composed of live cattle futures, lean hog futures, and feeder cattle futures, had experienced the biggest decline in the ratio of pit trading over the years examined in their study. Our focus in livestock futures is partially based on this observation, but also on the fact that livestock futures, and especially live

[1] Polanskek, T. (2015, June 24th). CME traders push regulator to delay futures pit closure by 90 days. Reuters. Retrieved on October 12th 2015 from http://www.reuters.com/article/2015/06/24/cme-group-futures-closure-cftc-idUSL1N0ZA2DS20150624
Stebbins C. (2015, July 23rd). CME fields complaints on soy crush spread after futures pits close. Retrieved on October 26th 2015 from http://www.reuters.com/article/2015/07/23/cmegroup-markets-meeting-idUSL1N1031ZH20150723

[2] Total trading volume in 2015 for live cattle futures was 13,440,934 contracts, for lean hog futures 9,575,882 contracts, and for feeder cattle futures 2,493,051 contracts.

[3] For a detailed description of the effect of settlement procedure changes, see Onur and Reiffen (2016).

4" Welcome to the 'Meat Casino'! The Cattle Futures Market Descends Into Chaos," Wall Street Journal, August 17, 2016: https://www.wsj.com/articles/welcome-to-the-meat-casino-the-cattle-futures-market-descends-into-chaos-1471475438

cattle futures, has been criticized for its high volatility and unstable market structure within the last few years[5].

This paper adds to the growing literature on livestock futures. Shang, Mallory, and Garcia (2016) analyze the bid ask spread behavior in the electronic live cattle futures markets and show that the bid ask spread in the live cattle futures widened during the volatiles periods of 2014 and 2015. They also show that adverse selection cost component is small whereas order processing cost is the largest component. Frank and Garcia (2010) use modified Bayesian methodology to analyze the bid ask estimators in live cattle futures markets and find that bid ask spread in this market is negatively correlated with volume and positively correlated with price volatility. Among others, the futures markets analyzed in Gousgounis and Onur (2016) also include livestock futures and their analysis focuses on documenting the changes in various features of the futures markets such as main trading hours, pit traders, and execution costs for the whole market. Finally, Haynes et. al. (2017) use the same data set we utilize in our study and analyze the effect of increased algorithmic trading on livestock futures market liquidity and pricing efficiency.

This study improves the existing literature on three distinct ways. First, it focuses on execution costs specific to customers using a rich transaction level data from the U.S. Commodity Futures Trading Commission (CFTC). The analysis employs a two stage estimation to account for aggressive and passive executions costs and estimate them separately. Second, it measures execution costs of orders, not transactions. This modification is quite important since as markets have become more and more electronic, transaction sizes have shrank all around the world. Orders have been shredded to smaller and smaller pieces to avoid any kind of price impact. In a market where transactions are happening more frequently and in smaller sizes, it is important to measure the true cost of transaction by focusing on orders. Finally, we make use of volatility signature plots to determine the exact time frame to calculate our execution costs[6]. Any execution cost calculation based on calendar time is subject to criticism about how long it would truly take for permanent price impact to be incorporated into the prices[7]. Our approach uses a methodology that aims at choosing the shortest time frame that is immune to microstructure noise.

Our main findings indicate that customers placing aggressive orders in the livestock market face higher execution costs after the pit closed, due to higher search costs. At the same time, customers placing passive orders receive higher compensation for providing liquidity following the pit closure, but the net effect is an increase in execution costs.

2. Data

Our dataset includes transaction data on futures during the time period extending from June 1st 2014 to June 1st 2016. The dataset, constructed using the Transaction Capture Report database of the U.S. Commodity Futures Trading Commission (CFTC), includes detailed transaction information, such as the price and quantity of every futures trade and the execution venue

[5] See Mulvany 2016, and Meyer 2016.
[6] This methodology was previously successfully used by Brunetti, Buyuksahin, and Harris (2016).
[7] See Conrad and Wahal (2016) for a thorough discussion of the importance of time selection.

(electronic, pit and block trades). The dataset also provides an order identifier, which allows us to bunch traders belonging to the same order. Other useful information in the dataset are indicators for whether a particular trade was part of a trading strategy, and a flag for who initiated the trade (buy side vs. sell side) for electronic transactions. Finally, the dataset identifies counterparties to a transaction and provides information on market participants, such as the identification number for each trader, and the trading role of each customer account, as measured by the customer type indicator (CTI) code.

One of the key variables we use in our analysis is an aggressor indicator. As mentioned above, we have information on which side of the transaction initiates the trade, which is also known as the aggressive side. We then calculate a volume weighted measure of aggressiveness for every order from each transaction that is part of that order. This variable is important because we model the decision to place an aggressive or a passive order as endogenous in our analysis.

3. Methodology Description

We explore the potential impact of the pit closure on the liquidity of the electronic market, as measured by execution costs. Since, our dataset allows us to consolidate trades in their originating order; we estimate execution costs for those originating orders, deviating from the literature, which estimates execution costs using just the aggressive side of each trade. In more detail, we proxy execution costs for electronic orders using the effective half spread, which is estimated as:

$$Effective\ half\ spread = 100 * Di\ * (log(Pt0) - log(Ptbenchmark)),$$

where log represents the natural logarithm, Pt0 is the volume weighted transaction price of each order, and Ptbenchmark is the average price of trades occurring in the five minute interval preceding the first trade of each order. The variable Di is a trade direction indicator where Di= 1 for a buy order and Di= - 1 for a sell order. Notably, our sample includes both passive and aggressive orders, since customer trades can originate from either one. We expect aggressive (passive) customer orders to have positive (negative) execution costs. While we are interested in the total effect on the costs of trading for customers in the electronic market, we also want to explore whether this potential effect is driven by aggressive or passive orders. the trade initiation indicator, which allows us to separate aggressive and passive trades, we designate an order aggressive (passive), if more (less) than fifty percent of the order's traded volume corresponds to trades initiated by the particular customer[8]. We are also interested in decomposing the effective half spread into a temporary and permanent components:

$$Temporary\ impact = 100 * Di * (log(Pt0) - log(Pt1)),$$

and

[8] There are very few cases in which the aggressive and passive transactions associated with an order are equivalent in volume. In most cases, orders are composed of mostly aggressive trades or mostly passive trades.

$$Permanent\ impact = Di * (log(Pt1) - log(Ptbenchmark))$$

where Pt1 is the average price of the electronic outright trades occurring between the fifth and tenth minute, following each trade. The temporary spread represents compensation for search and negotiation costs, while the permanent spread represents the permanent price impact. Similar to the literature, we consider trades to be informed (liquidity driven) when the permanent spread constitutes a high (low) proportion of the effective half spread.

We assume that the timeframe for Pt1 should coincide with the timeframe of the post transaction noise. Thus, to determine this timeframe, we create an intraday volatility signature plot for each commodity (live cattle, lean hog, feeder cattle), following an approach similar to Brunetti et al (2016). More specifically, we estimate the realized volatility for each commodity and each contract:

$$Realized\ Volatility = \sqrt{\sum_{t=1}^{n} {r_t}^2}$$

Where r represents returns for a specific sub-interval and n is the number of such sub-intervals in each day. We estimate realized volatility for the following sub-intervals: 1 second, 10 seconds, 30 seconds, 1 minute, 3 minute, 5 minute, 10 minutes, 30 minutes and 1 hour. In each case, we estimate the volume weighted realized volatility across different maturities. We plot them creating the volatility signature plots for each livestock futures contract presented in Figure 1. The first graph presents the volatility signature plot for live cattle futures, whereas the second and third graphs present the signature volatility plots for lean hog and feeder cattle respectively. All volatility signature plots appear to flatten out between 300 and 600 seconds (5-10 minutes). Therefore, we believe that any price impact beyond the 10 minute mark should be assumed to be permanent. We model execution costs of customer orders using a two stage endogenous switching regression:

$$y_i = z_i'\gamma + u_i$$

$$c_i = x_i'\beta + \varepsilon_i$$

where the first equation estimates the probability that a customer order i was aggressive ($y_i = 1$) or passive ($y_i = 0$), where the second equation estimates the execution cost c_i. The errors u_i, ε_i are jointly normal with zero mean and standard deviations 1 and σ respectively, and correlation ρ.

The first stage of the model is a probit regression representing the decision to position each customer order i as aggressive (y_i=1) or passive (y_i=0). The explanatory variables, z_i, include market characteristics, such as realized volatility and volume as well as order characteristics, such as the size of the order. Realized volatility is estimated as the square root of the sum of five minute squared returns during the hour before the order started executing. Volume is measured as the logarithm of the volume of futures traded during the hour before the order started executing.

The second stage of the model estimates the execution costs of customer orders conditional on the order being aggressive or passive[9]:

$$E[c_i|y_i = 1] = x_i'\beta_a + \rho_a\sigma_a\left[\frac{\varphi(z_i'\gamma)}{\Phi(z_i'\gamma)}\right]$$

$$E[c_i|y_i = 0] = x_i'\beta_p + \rho_p\sigma_p\left[-\frac{\varphi(z_i'\gamma)}{1-\Phi(z_i'\gamma)}\right]$$

where $\varphi(.)$ Denotes the standard normal density function, and $\Phi(.)$ denotes the cumulative standard normal distribution. The second terms in each equation correct for selection bias. They represent nonlinear combinations of the variables used to predict the decision to use an aggressive or a passive order. If $\rho_a\sigma_a$ and $\rho_p\sigma_p$ are equal to zero, the selection of using an aggressive or a passive order should not affect execution costs.

The model is estimated for the effective half spread, the temporary impact, and the permanent impact separately. The explanatory variables, x_i, include order characteristics (order size, the contract's time to expiration, a dummy indicating whether the order is manual, a dummy indicating whether the order belongs to a strategy), the realized volatility and a dummy indicating whether the order was placed before or after the pit closure. Additional control variable include dummies controlling for the change of the settlement procedure in December 2014, changes in the trading hours, and on whether the order was placed on a Monday or a Friday. The latter two dummies control for the effect of announcements of cash market auction results, which typically occur on Mondays.

4. Analysis

4.1 Descriptive statistics

Our objective is to evaluate the potential impact of the pit closure on the execution costs faced by customers[10] in the livestock market. First, we present summary statistics describing the trading behavior of livestock customers before and after the pit closure. We focus our analysis on those customers that were active in the market prior to the announcement of the pit closure (on February 4th 2015) and we follow their behavior until the end of our sample. As expected, some of the customers drop from our sample after the announcement of the pit closure. We separate customers to those who, prior to the pit closure, traded exclusively in the electronic market and those who were using the pit for at least some of their transactions. Table 1 presents the trading patterns of customers in the live cattle futures market. Our summary statistics suggest that the pit customers were executing about 40% of their daily trading volume at the pit. While the number of customers active at the pit was relatively small, those customers appear to be responsible for a substantial

[9] The model is estimated twice: first aggressive and then for passive orders.
[10] We use the exchange's CTI code to determine customer accounts

trading volume and exhibit substantially higher average trading volume compared to those customers trading exclusively in the electronic market. Moreover, pit users are more likely to trade strategies than the electronic customers. Interestingly, most customers place manual trades irrespective of the trading venue. Also, our dataset provides information on the cti code[11] of opposing traders. We show that customers who traded exclusively on the electronic platform tend to trade with other customers (cti code=4) about 40% of the time. They also trade with proprietary traders (cti code=2) about 40% of the time. However, this proportion reaches close to 50% after the pit closure. Across all customer transactions, the percentage of trading with traditional market makers (cti code=1) seems to decline after the pits close. Also, as expected, many of the pit users transition to the electronic market in the second half of our sample. Table 2 presents the trading patterns of customers in the lean hog futures market. The trading behavior of customers in this market is similar to the behavior of customers in the live cattle market. One difference is that pit users seem as likely as customers trading exclusively on the electronic platform to place strategy orders. Also, pit users in the lean hog futures market were trading a slightly higher proportion of their volume at the pit (45%) prior to the pit closure announcement, compared with customers in the live cattle futures market. Table 3 presents similar statistics for the customers trading feeder cattle futures. The trading behavior of customers in the feeder cattle futures market mimics that of the customers in the live cattle futures market. However, we should note that the average trading volume for feeder cattle futures customers is smaller than that in the live cattle futures market.

Overall, our analysis suggests a significant jump in trading with proprietary traders

As mentioned earlier, customers in the livestock futures market do not appear to place automated trades. This result persists irrespective of whether they use the pit and the time period examined. At the same time, they often trade with proprietary traders and the frequency of such trades seems to have increased after the announcement of the pit closure. Given that automated trading in livestock futures markets is expected to be tied to proprietary traders (cti code=2), we examine the relationship between the proportion of automated trading in the market and the customers' tendency to place aggressive orders. Figure 2 presents the corresponding graphs for each livestock futures contract. Customer aggressiveness measures the average proportion of

[11] The Chicago Mercantile Exchange (CME) specifies the CTI codes as follows:

"CTI 1: Electronic Trading, Open Outcry and Privately Negotiated – Applies to transactions initiated and executed by an individual member for his own account, for an account he controls, or for an account in which he has an ownership or financial interest. However, transactions initiated and executed by a member for the proprietary account of a member firm must be designated as CTI 2 transactions.

CTI 2: Electronic Trading, Open Outcry and Privately Negotiated – Applies to orders entered or trades executed for the proprietary accounts of a member firm.

CTI 3: Electronic Trading – Applies to orders entered by a member or a nonmember terminal operator for the account of another individual member or an account controlled by such other individual member. CTI 3: Open Outcry and Privately Negotiated – Applies to orders that a member executes on behalf of another individual member, or for an account such other member controls or in which such other member has an ownership or financial interest.

CTI 4: Electronic Trading Open Outcry and Privately Negotiated – Applies to all orders and transactions not included in CTI categories 1, 2 or 3. These typically are orders entered by or on behalf of nonmember entities."

Source: CME Group. (2014, April 2). Market Regulation Advisory Notice, Rule 536.D, Retrieved from www.cmegroup.com/rulebook/files/cme-group-ra1401-5.pdf

aggressive electronic orders across customers in a given market, while market automation measures the proportion of automated trades in the market as a whole. We observe that market automation appears to have increased in all livestock markets after the pit closure. Customer aggressiveness follows a slight upward trend in the live cattle futures market. This trend is less pronounced in the lean hog futures market and it is nonexistent in the feeder cattle futures market.

These results suggest that while examining the effect of the pit closure on the execution costs faced by customers, we should not limit our analysis on total execution costs: instead we should also evaluate this effect for aggressive and passive customer orders separately. Figure 3 presents the average effective half spread for aggressive and passive orders separately. The first graph presents the effective half spread for live cattle futures, while the second and third graphs present the effective half spread for lean hog and feeder cattle futures respectively. As expected, aggressive orders exhibit a positive effective half spread while passive orders exhibit on average a negative effective half spread. The effective half spread for aggressive orders seems to have increased after the announcement of the pit closure and the pit closure itself. While the effective half spread for passive orders follows a similar but opposite pattern, it is not clear whether the magnitude is the same, whether the increased costs of aggressive orders are offset by a higher "benefit" associated with passive orders.

4.2 Multivariate results

In order to properly evaluate the effect of the pit closure on the execution costs of faced by customers in the livestock futures market, we first examine this effect for the aggregate execution costs faced by customers. Then, we employ the two stage endogenous switching regression described in section 3 to evaluate the effect of the pit closure on aggressive and passive orders separately. Table 4 presents the corresponding results for the effective half spread of customers in the live cattle market. The first column shows the results of the simple OLS regression, while the second and third columns present the results of the respective endogenous switching regressions for aggressive and passive orders. The bottom half of the table presents the corresponding first stage probit regressions. The table provides the coefficient estimates followed by the corresponding p-values in italics. The pit closure dummy takes the value one after the pit closure and zero in the time period before July 6th 2015. The effect of the pit closure on all orders appears to be positive and significant, indicating that customers trading live cattle futures in the electronic market face higher effective half spread after the pit closure. We then examine this effect on aggressive and passive orders separately, accounting for the selection bias. The coefficient is negative and significant for both aggressive and passive orders, indicating that customers placing aggressive orders in the electronic market pay a lower effective half spread after the pit closure, while customers with passive orders receive a higher compensation for providing liquidity in the market. As expected, realized volatility reduces the effective half spread for both aggressive and passive orders. Effective half spread is also higher (lower) for large manual aggressive (passive) orders. Orders belonging to a strategy (spread dummy) and higher time to expiration exhibit a

lower (higher) effective half spread for aggressive (passive) electronic customer orders. Finally, the correlation and standard deviation coefficients confirm the presence of selection bias and the need to adjust for it.

To better understand the effect of the pit closure on the execution costs of livestock futures contracts we repeat the same analysis for the temporary and permanent impact. Table 5 presents the results when we examine the effect of the pit closure on the temporary impact of electronic customer orders and Table 6 presents our results when we use permanent impact as our proxy for the execution costs of livestock futures contracts. The effect of the pit closure on temporary impact is positive (negative) and significant for aggressive (passive) customer orders. The permanent impact is lower for both aggressive and passive orders, which indicates that that the higher effective half spread for aggressive customer orders should be attributed to higher search costs, as suggested by the higher temporary impact.

Tables 7-9 present a similar analysis for the lean hog futures market. Table 7 examines the effect of the pit closure on the effective half spread faced by customers trading lean hog futures in the electronic market. Table 8 examines the effect of the pit closure on the temporary impact faced by customers trading lean hog futures, while Table 9 examines the effect of the pit closure on the permanent impact. The effective half spread is higher for aggressive and lower for passive orders following the pit closure. However, overall execution costs are higher for customers after the closure of the pit. The temporary impact is higher after the pit closure for both aggressive and passive customer orders, although results are stronger for aggressive orders. Table 9 shows that after the pit closure passive customer orders face lower permanent impact. This suggests that, similar to live cattle futures, aggressive electronic customer orders face a higher execution cost, which is due to higher search costs. At the same time passive orders exhibit a lower permanent impact which could mean that passive orders may have lower information content.

Tables 10-12 present our results for the feeder cattle futures market. Table 10 evaluates the effect of the pit closure on the effective half spread of customer orders in the electronic market. Table 11 examines any potential changes in the temporary impact of feeder cattle customer orders, while Table 12 presents the effect of the pit closure on the permanent impact of these orders. Customers trading feeder cattle generally face higher costs after the pit closure. The effective half spread is higher (lower) for aggressive (passive) customer orders following the closure of the pit, which seems to be driven by higher (lower) temporary impact for aggressive (passive) orders. Moreover, the permanent impact is lower for both aggressive and passive orders following the pit closure.

5. Conclusion

Closure of pits by the CME in July of 2015 was a significant change for many market participants. In this paper we ask how this change impacted execution costs for customer orders in the livestock futures market. We make use of a rich, regulatory transaction level data and measure the effect of pit closure on effective half spread, permanent impact and temporary impact of customer orders.

When executing a trade, a trader has the choice of using an aggressive order or a passive order. Our analysis employs a two stage estimation to account for this choice while estimating execution costs. In addition, we measure execution costs of orders, not transactions. With increased electrification, orders have been shredded to smaller sized transactions and measuring transaction costs simply from transactions can be quite misleading. Finally, we make use of volatility signature plots to determine the exact time frame to calculate our execution costs, avoiding the criticism about how long it would truly take for permanent price impact to be incorporated into the prices.

Our results indicate that customers placing aggressive orders in the livestock market face higher search costs, contributing to higher total execution costs, especially for lean hogs and feeder cattle futures. At the same time, customers placing passive orders receive higher compensation for providing liquidity following the pit closure, but the net effect is an increase in execution costs.

References:

Brunetti, C., B. Buyuksahin and J. Harris (2016), Speculators, Prices and Market volatility, Journal of Financial and Quantitative Analysis, 51, 1545-1574.

CME Group. (2014, April 2). Market Regulation Advisory Notice, Rule 536.D, Retrieved from www.cmegroup.com/rulebook/files/cme-group-ra1401-5.pdf

Conrad, J., S. and S. Wahal (2016), The Term Structure of Liquidity Provision, SSRN Working Paper.

Gousgounis, E. and E. Onur (2016), The Effect of Pit Closure on Futures Trading, CFTC White Papers.

Haynes, R., V. Raman, M. A. Robe, and P. K. Yadav (2017), Automation and Livestock Market Quality, CFTC Research paper.

Shang, Q., M. Mallory, and P. Garcia. 2016. "The Electronic Live Cattle Futures Market Bid Ask Spread Behaviors and Components" Agricultural and Applied Economics Association>2016 Annual Meeting, July 31-August 2, Boston, Massachusetts.

Frank, Julieta, and Philip Garcia. 2010. "Bid-Ask Spreads, Volume, and Volatility: Evidence from Livestock Markets." American Journal of Agricultural Economics. Oxford University Press, aaq116.

Meyer, George. 2016. "Cattlemen Lock Horns with Futures Exchange over Market Volatility."

Mulvany, Lydia. 2016. "CME Says Cattle Market May Be ' Broken ' as Volatility Soars."

Tables

Table 1 shows the customer statistics for Live Cattle Futures.

	Live Cattle (48)			
	Electronic users (exclusively)		Pit users	
	Before the pit closure	After the pit closure	Before the pit closure	After the pit closure
Total volume	9,129,995	6,333,429	3,643,860	2,135,632
Number of customers	20,393	9,069	935	523
Average daily volume	13.13	15.54	57.50	46.72
Average spread volume %	0.23	0.23	0.41	0.47
Average electronic volume %	1	1	0.61	0.98
Average pit volume %	0	0	0.39	0.02
Average manual volume %	0.96	0.96	0.99	0.96
Average volume trading with CTI1 %	0.14	0.08	0.35	0.09
Average volume trading with CTI2 %	0.40	0.48	0.25	0.49
Average volume trading with CTI3%	0.01	0.01	0.03	0.01
Average volume trading with CTI4 %	0.44	0.42	0.36	0.41

Table 2 shows the customer statistics for Lean Hogs Futures.

	Lean Hogs (LN)			
	Electronic users (exclusively)		Pit users	
	Before the pit closure	After the pit closure	Before the pit closure	After the pit closure
Total volume	6,575,867	3,728,728	2,583,876	1,034,104
Number of customers	13,821	5,251	770	351
Average daily volume	13.84	17.82	48.98	45.50
Average spread volume %	0.29	0.30	0.30	0.31
Average electronic volume %	1	1	0.55	0.98
Average pit volume %	0	0	0.45	0.02
Average manual volume %	0.95	0.94	0.98	0.96
Average volume trading with CTI1 %	0.18	0.12	0.34	0.12
Average volume trading with CTI2 %	0.39	0.45	0.22	0.46
Average volume trading with CTI3%	0.02	0.01	0.05	0.01
Average volume trading with CTI4 %	0.41	0.42	0.39	0.41

Table 3 shows the customer statistics for Feeder cattle.

	Feeder Cattle (62)			
	Electronic users (exclusively)		Pit users	
	Before the pit closure	After the pit closure	Before the pit closure	After the pit closure
Total volume	2,114,721	1,316,669	376,453	151,281
Number of customers	13,914	5,563	396	178
Average daily volume	5.74	6.97	18.48	19.26
Average spread volume %	0.17	0.15	0.25	0.27
Average electronic volume %	1	1	0.57	0.99
Average pit volume %	0	0	0.43	0.01
Average manual volume %	0.97	0.96	0.98	0.94
Average volume trading with CTI1 %	0.12	0.08	0.36	0.09
Average volume trading with CTI2 %	0.39	0.49	0.33	0.46
Average volume trading with CTI3%	0.01	0.01	0.02	0.01
Average volume trading with CTI4 %	0.48	0.42	0.28	0.44

Table 4: Effective half spread – Live cattle futures

Live Cattle (48)			
	Effective half spread		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0026***	-0.0672***	-0.0537***
	<.0001	*<.0001*	*<.0001*
Order size	0.0053***	0.0102***	-0.0021***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0039***	0.0078***	-0.0183***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.0041***	-0.0412***	0.0266***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.005***	-0.0036***	0.0125***
	<.0001	*<.0001*	*<.0001*
Monday dummy	0.0007***	-0.0004***	0.0023***
	<.0001	*<.0001*	*<.0001*
Friday dummy	-0.0001*	-0.0001	-0.0002**
	0.0975	*0.5561*	*0.0470*
Trading hours change dummy 1	0.0001	0.0002	0.0006***
	0.3322	*0.1797*	*<.0001*
Trading hours change dummy 2	-0.0003**	0.0022***	-0.0006***
	0.0395	*<.0001*	*<.0001*
Settlement change dummy	-0.0016***	0.0004***	-0.0033***
	<.0001	*0.0121*	*<.0001*
Pit closure dummy	0.0003***	-0.0005***	-0.003***
	0.0006	*<.0001*	*<.0001*
Realized volatility	-0.4489***	-0.2933***	-1.4634***
	<.0001	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.323***	-0.1729***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0727***	0.101***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.2446***	-0.2309***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		8.785***	-23.9506***
		<.0001	*<.0001*
_Rho		0.7565***	-0.5756***
		<.0001	*<.0001*
_Sigma.effective half spread		0.1229***	0.115***
		<.0001	*<.0001*
Observations (passive orders)		11,340,051	11,086,307
Observations (aggressive orders)		6,739,763	6,837,870
Observations (Total)	17,826,070	18,079,814	17,924,177
Mean		0.0196	-0.0153
stdev		0.0973	0.1047
R^2	0.0019		

Table 5: Temporary impact – Live cattle futures

Live Cattle (48)			
	Temporary impact		
	All orders	Aggressive orders	Passive orders
Intercept	0.0037***	0.1553***	-0.0828***
	<.0001	*<.0001*	*<.0001*
Order size	0.0007***	-0.0107***	-0.0041***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	0.0006***	0.0028***	-0.0004***
	<.0001	*<.0001*	*0.0020*
Spread dummy	-0.0038***	0.0235***	0.0136***
	<.0001	*<.0001*	*<.0001*
Years to expiration	-0.0008***	0.0016***	-0.0013***
	<.0001	*<.0001*	*<.0001*
Monday dummy	0.0006***	0.0016***	-0.0006***
	0.0005	*<.0001*	*<.0001*
Friday dummy	-0.0003**	-0.0012***	0.0004***
	0.0485	*<.0001*	*0.0118*
Trading hours change dummy 1	-0.0004*	-0.0001	-0.0001
	0.0772	*0.8462*	*0.6726*
Trading hours change dummy 2	0.0003	0.0006***	0.0003
	0.1247	*0.0054*	*0.1741*
Settlement change dummy	0.0000	0.001***	-0.0008***
	0.9948	*0.0004*	*0.0002*
Pit closure dummy	-0.0002	0.0036***	-0.0029***
	0.1608	*<.0001*	*<.0001*
Realized volatility	-0.0879***	0.9719***	0.3176***
	0.0068	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.3201***	-0.1496***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0816***	0.0747***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.2429***	-0.2234***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		5.1394***	-23.5713***
		<.0001	*<.0001*
_Rho		-0.7309***	-0.6352***
		<.0001	*<.0001*
_Sigma.effective half spread		0.2169***	0.2093***
		<.0001	*<.0001*
Observations (passive orders)		11,340,051	11,049,767
Observations (aggressive orders)		6,673,014	6,837,870
Observations (Total)	17,722,781	18,013,065	17,887,637
Mean		0.0039	0.0002
stdev		0.1722	0.1843
R^2	0.0001		

Table 6: Permanent impact – Live cattle futures

Live Cattle (48)			
	Permanent impact		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0065***	-0.1616***	-0.0984***
	<.0001	*<.0001*	*<.0001*
Order size	0.0047***	0.0165***	-0.0089***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0045***	0.0056***	-0.0191***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.0003**	-0.0534***	0.0391***
	0.0220	*<.0001*	*<.0001*
Years to expiration	0.0062***	-0.005***	0.0158***
	<.0001	*<.0001*	*<.0001*
Monday dummy	0.0001	-0.0021***	0.0037***
	0.5857	*<.0001*	*<.0001*
Friday dummy	0.0001	0.0012***	0.0002
	0.4413	*<.0001*	*0.1413*
Trading hours change dummy 1	0.0005**	-0.0001	0.0014***
	0.0422	*0.7077*	*<.0001*
Trading hours change dummy 2	-0.0005*	-0.0007***	-0.0008***
	0.0555	*0.0050*	*0.0001*
Settlement change dummy	-0.0017***	-0.0003	-0.0044***
	<.0001	*0.3316*	*<.0001*
Pit closure dummy	0.0005***	-0.0019***	-0.0016***
	0.0017	*<.0001*	*<.0001*
Realized volatility	-0.3546***	-0.1389***	-1.7693***
	<.0001	*<.0001*	*<.0001*
Aggressor dummy .Intercept		-0.3253***	-0.1719***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0726***	0.1051***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.2468***	-0.2173***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		7.1271***	-23.8957***
		<.0001	*<.0001*
_Rho		0.7563***	-0.5967***
		<.0001	*<.0001*
_Sigma.effective half spread		0.242***	0.2297***
		<.0001	*<.0001*
Observations (passive orders)		11,340,051	10,832,637
Observations (aggressive orders)		6,593,164	6,837,870
Observations (Total)	17,425,801	17,933,215	17,670,507
Mean		0.0159	-0.0156
stdev		0.1888	0.2061
R^2	0.0004		

Table 7: Effective half spread - Lean hog futures

Lean Hogs (LN)			
	Effective half spread		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0018***	0.0185***	-0.0673***
	<.0001	*<.0001*	*<.0001*
Order size	0.0082***	0.0112***	-0.0007***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0092***	0.0078***	-0.0277***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.0122***	-0.0409***	0.0128***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.0099***	-0.0009***	0.0189***
	<.0001	*<.0001*	*<.0001*
Monday dummy	0.0004**	-0.0005***	0.000
	0.0454	*0.0020*	*0.9218*
Friday dummy	-0.0007***	-0.0007***	-0.0008***
	<.0001	*<.0001*	*<.0001*
Trading hours change dummy 1	-0.0021***	0.0000	0.0000
	<.0001	*0.9245*	*0.8898*
Trading hours change dummy 2	0.0008***	-0.004***	0.0041***
	<.0001	*<.0001*	*<.0001*
Settlement change dummy	0.0014***	0.0071***	-0.0058***
	<.0001	*<.0001*	*<.0001*
Pit closure dummy	0.0005***	0.0032***	-0.0032***
	0.0065	*<.0001*	*<.0001*
Realized volatility	0.0955***	2.1082***	-0.7518***
	0.0054	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.2004***	-0.1597***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0244***	0.0697***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.0176***	-0.0075***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		-8.2869***	-19.4267***
		<.0001	*<.0001*
_Rho		-0.0011	-0.5407***
		0.8545	*<.0001*
_Sigma.effective half spread		0.1383***	0.1591***
		<.0001	*<.0001*
Observations (passive orders)		7,168,020	6,984,501
Observations (aggressive orders)		4,759,573	11,820,122
Observations (Total)	11744074	11927593	6984501
Mean		0.0313	-0.0217
stdev		0.1406	0.1458
R^2	0.0035		

Table 8: Temporary impact – Lean hogs futures

Lean Hogs (LN)			
	Temporary impact		
	All orders	Aggressive orders	Passive orders
Intercept	0.0014***	0.0143***	0.1127***
	0.0023	*<.0001*	*<.0001*
Order size	0.0017***	-0.0033***	0.0088***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	0.0005**	0.0005*	0.0019***
	0.0235	*0.0693*	*<.0001*
Spread dummy	-0.0053***	-0.0095***	-0.003***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.0027***	0.0085***	-0.0043***
	<.0001	*<.0001*	*<.0001*
Monday dummy	0.0025***	0.0044***	0.0037***
	<.0001	*<.0001*	*<.0001*
Friday dummy	-0.0005*	0.0018***	-0.0026***
	0.0623	*<.0001*	*<.0001*
Trading hours change dummy 1	-0.0016***	0.0024***	-0.0053***
	<.0001	*<.0001*	*<.0001*
Trading hours change dummy 2	0.0000	-0.003***	-0.0001
	0.9641	*<.0001*	*0.7637*
Settlement change dummy	0.0001	0.0012**	0.0014***
	0.7801	*0.0115*	*0.0002*
Pit closure dummy	0.0009***	0.0014***	0.0015***
	0.0017	*<.0001*	*<.0001*
Realized volatility	0.3553***	-0.8103***	0.701***
	<.0001	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.2346***	-0.1251***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0384***	0.0358***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.0185***	0.0015**
		<.0001	*0.0435*
Aggressor dummy. Realized volatility		-6.6126***	-20.9919***
		<.0001	*<.0001*
_Rho		-0.0001	0.618***
		0.9883	*<.0001*
_Sigma.effective half spread		0.2515***	0.2981***
		<.0001	*<.0001*
Observations (passive orders)		7,168,020	6,941,875
Observations (aggressive orders)		4,681,855	4,835,621
Observations (Total)	11623730	11849875	11777496
Mean		0.0084	0.0004
stdev		0.2516	0.2631
R^2	0.0002		

Table 9: Permanent impact- Lean hog futures

Lean Hogs LN (LN)			
	Permanent impact		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0034***	0.0046*	-0.133***
	<.0001	*0.0667*	*<.0001*
Order size	0.0065***	0.0142***	-0.0109***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0095***	0.008***	-0.0293***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.0069***	-0.0314***	0.0139***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.0074***	-0.0095***	0.0233***
	<.0001	*<.0001*	*<.0001*
Monday dummy	-0.0021***	-0.005***	-0.002***
	<.0001	*<.0001*	*<.0001*
Friday dummy	-0.0003	-0.0024***	0.0018***
	0.4065	*<.0001*	*<.0001*
Trading hours change dummy 1	-0.0006	-0.0025***	0.0049***
	0.1852	*<.0001*	*<.0001*
Trading hours change dummy 2	0.001***	-0.0006	0.0039***
	0.0050	*0.1793*	*<.0001*
Settlement change dummy	0.0014***	0.006***	-0.0062***
	0.0005	*<.0001*	*<.0001*
Pit closure dummy	-0.0006*	0.0017***	-0.0049***
	0.0778	*<.0001*	*<.0001*
Realized volatility	-0.2406***	2.9136***	-1.5017***
	<.0001	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.2333***	-0.1595***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0265***	0.0741***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.0189***	0.0107***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		-6.0436***	-21.7512***
		<.0001	*<.0001*
_Rho		-0.0009	-0.602***
		0.9178	*<.0001*
_Sigma.effective half spread		0.2746***	0.3301***
		<.0001	*<.0001*
Observations (passive orders)		7,168,020	6,786,900
Observations (aggressive orders)		4621159.0000	4835621.0000
Observations (Total)	11408059	11789179	11622521
Mean		0.0232	-0.0222
stdev		0.2756	0.2938
R^2	0.0005		

Table 10: Effective half spread – Feeder Cattle futures

Feeder cattle (62)			
	Effective half spread		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0083***	-0.091***	-0.0651***
	<.0001	*<.0001*	*<.0001*
Order size	0.011***	0.0197***	-0.0015***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0018***	0.0104***	-0.0143***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.0018***	-0.0745***	0.0481***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.0018***	-0.0103***	0.0071***
	<.0001	*<.0001*	*<.0001*
Monday dummy	-0.0007***	-0.0014***	-0.0001
	0.0006	*<.0001*	*0.5548*
Friday dummy	-0.0006***	-0.0009***	-0.0002
	0.0013	*<.0001*	*0.3957*
Trading hours change dummy 1	-0.0001	0.0005	-0.0008***
	0.7034	*0.2060*	*0.0093*
Trading hours change dummy 2	-0.0003	0.0013***	-0.0029***
	0.2191	*<.0001*	*<.0001*
Settlement change dummy	-0.0002	0.0029***	-0.0019***
	0.4695	*<.0001*	*<.0001*
Pit closure dummy	0.0004**	0.0011***	-0.0012***
	0.0395	*<.0001*	*<.0001*
Realized volatility	-0.2145***	0.5552***	-1.5679***
	<.0001	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.3233***	0.2866***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.0796***	0.1505***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.4699***	-0.4594***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		6.7062***	-24.344***
		<.0001	*<.0001*
_Rho		0.7973***	-0.5698***
		<.0001	*<.0001*
_Sigma.effective half spread		0.1449***	0.1297***
		<.0001	*<.0001*
Observations (passive orders)		3097379	2,981,653
Observations (aggressive orders)		1518017	1,566,727
Observations (Total)	4499670	4615396	4,548,380
Mean		0.029322	-0.0170
stdev		0.111171	0.1194
R^2	0.0019		

Table 11: Temporary impact – Feeder Cattle futures

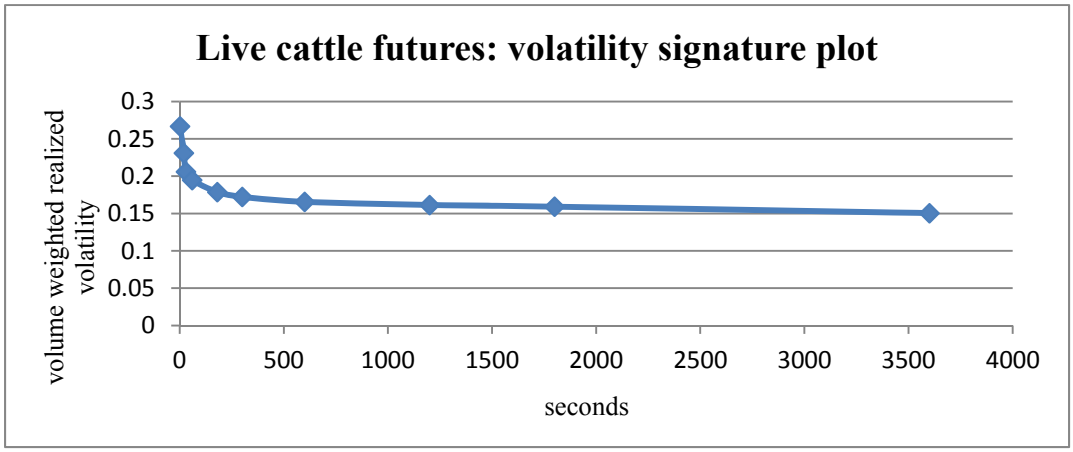
Feeder cattle (62)			
	Temporary impact		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0007	0.2007***	0.0895***
	0.2143	*<.0001*	*<.0001*
Order size	0.0032***	-0.0174***	0.0151***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	0.0033***	0.0044***	0.0042***
	<.0001	*<.0001*	*<.0001*
Spread dummy	-0.007***	0.0655***	-0.0456***
	<.0001	*<.0001*	*<.0001*
Years to expiration	0.0032***	0.0114***	0.0053***
	<.0001	*<.0001*	*<.0001*
Monday dummy	-0.0005	0.0006	-0.0011***
	0.2160	*0.1718*	*0.0018*
Friday dummy	-0.0001	-0.0002	-0.0006*
	0.8710	*0.5748*	*0.0966*
Trading hours change dummy 1	-0.0012***	-0.0028***	-0.0002
	0.0030	*0.0002*	*0.6932*
Trading hours change dummy 2	-0.001**	0.0022***	-0.0009**
	0.0320	*<.0001*	*0.0263*
Settlement change dummy	0.0011***	0.0036***	0.002***
	0.0050	*<.0001*	*0.0002*
Pit closure dummy	0.0009***	0.0092***	-0.0003
	0.0080	*<.0001*	*0.4090*
Realized volatility	0.1007	0.6868***	0.5298***
	0.1120	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.3492***	-0.1196***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.1023***	0.0962***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.4728***	-0.4496***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		4.6199***	-24.1393***
		<.0001	*<.0001*
_Rho		-0.7567***	0.608***
		<.0001	*<.0001*
_Sigma.effective half spread		0.2707***	0.2492***
		<.0001	*<.0001*
Observations (passive orders)		3,097,379	2,919,543
Observations (aggressive orders)		1,468,130	1,566,727
Observations (Total)	4,387,673	4,565,509	4,486,270
Mean		0.0050	0.0013
stdev		0.2092	0.2238
R^2	0.0004		

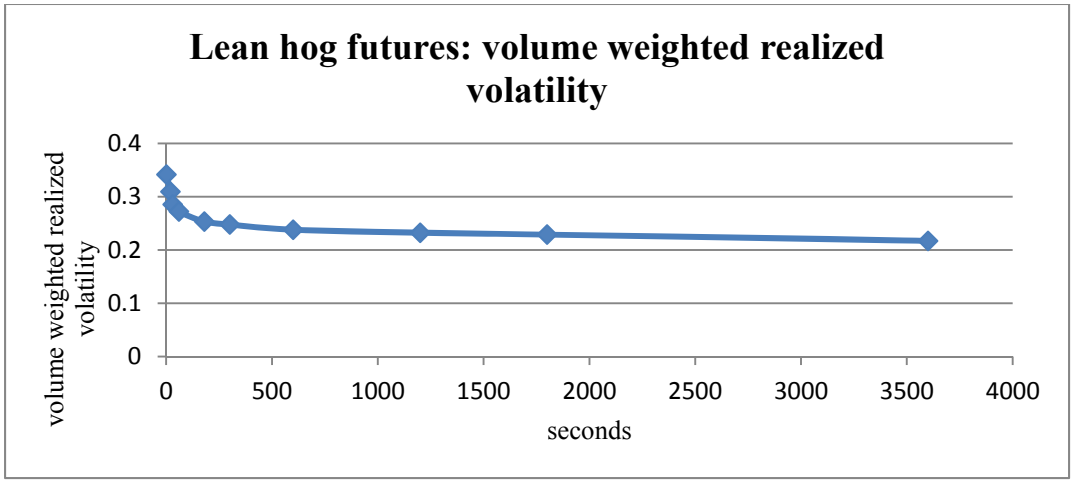
Table 12: Permanent impact – Feeder Cattle futures

Feeder cattle (62)			
	Permanent impact		
	All orders	Aggressive orders	Passive orders
Intercept	-0.0074***	-0.2201***	-0.1199***
	<.0001	*<.0001*	*<.0001*
Order size	0.0075***	0.0297***	-0.0186***
	<.0001	*<.0001*	*<.0001*
Manual order dummy	-0.0048***	0.006***	-0.0185***
	<.0001	*<.0001*	*<.0001*
Spread dummy	0.005***	-0.1158***	0.081***
	<.0001	*<.0001*	*<.0001*
Years to expiration	-0.0016**	-0.0213***	0.0005
	0.0271	*<.0001*	*0.4817*
Monday dummy	-0.0002	-0.0003	0.0018***
	0.6231	*0.5795*	*<.0001*
Friday dummy	-0.0004	-0.0014***	0.0005
	0.3055	*0.0037*	*0.2107*
Trading hours change dummy 1	0.0012***	0.0031***	-0.0006
	0.0053	*0.0002*	*0.3743*
Trading hours change dummy 2	0.0009*	-0.0001	-0.0013***
	0.0849	*0.8213*	*0.0053*
Settlement change dummy	-0.0013***	-0.0003	-0.0037***
	0.0030	*0.7156*	*<.0001*
Pit closure dummy	-0.0004	-0.0073***	-0.0007*
	0.2691	*<.0001*	*0.0687*
Realized volatility	-0.3349***	0.9101***	-2.1441***
	<.0001	*<.0001*	*<.0001*
		Probit	Probit
Aggressor dummy .Intercept		-0.3609***	0.3094***
		<.0001	*<.0001*
Aggressor dummy. Order size		0.081***	0.1548***
		<.0001	*<.0001*
Aggressor dummy. Spread dummy		-0.475***	-0.4436***
		<.0001	*<.0001*
Aggressor dummy. Realized volatility		7.7979***	-28.0326***
		<.0001	*<.0001*
_Rho		0.7914***	-0.6301***
		<.0001	*<.0001*
_Sigma.effective half spread		0.3052***	0.2782***
		<.0001	*<.0001*
Observations (passive orders)		3,097,379	2,828,613
Observations (aggressive orders)		1,431,573	1,566,727
Observations (Total)	4,260,186	4,528,952	4,395,340
Mean		0.0251	-0.0186
stdev		0.2293	0.2482
R^2	0.0003		

Figures

Figure 1: Volatility signature plots





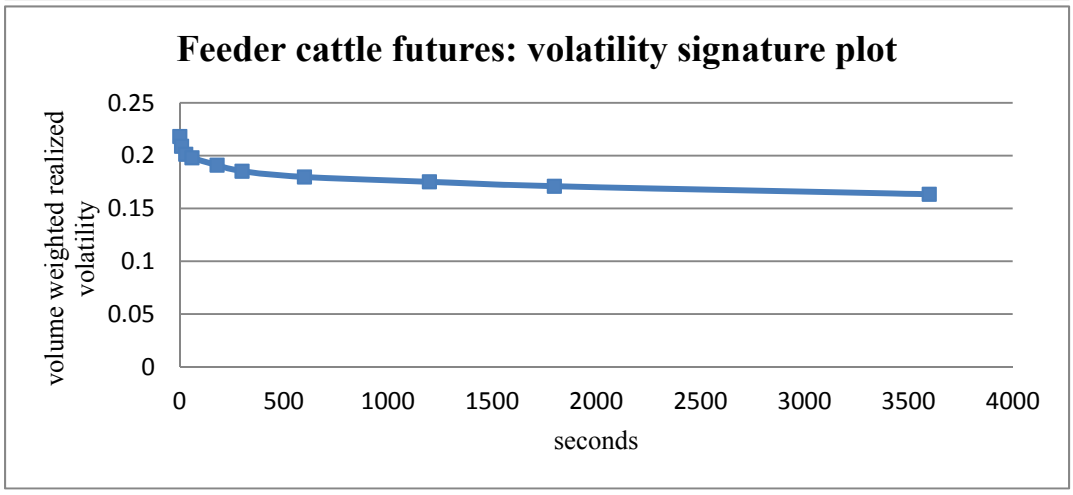


Figure 2: Customer aggressiveness and Market Automation by commodity

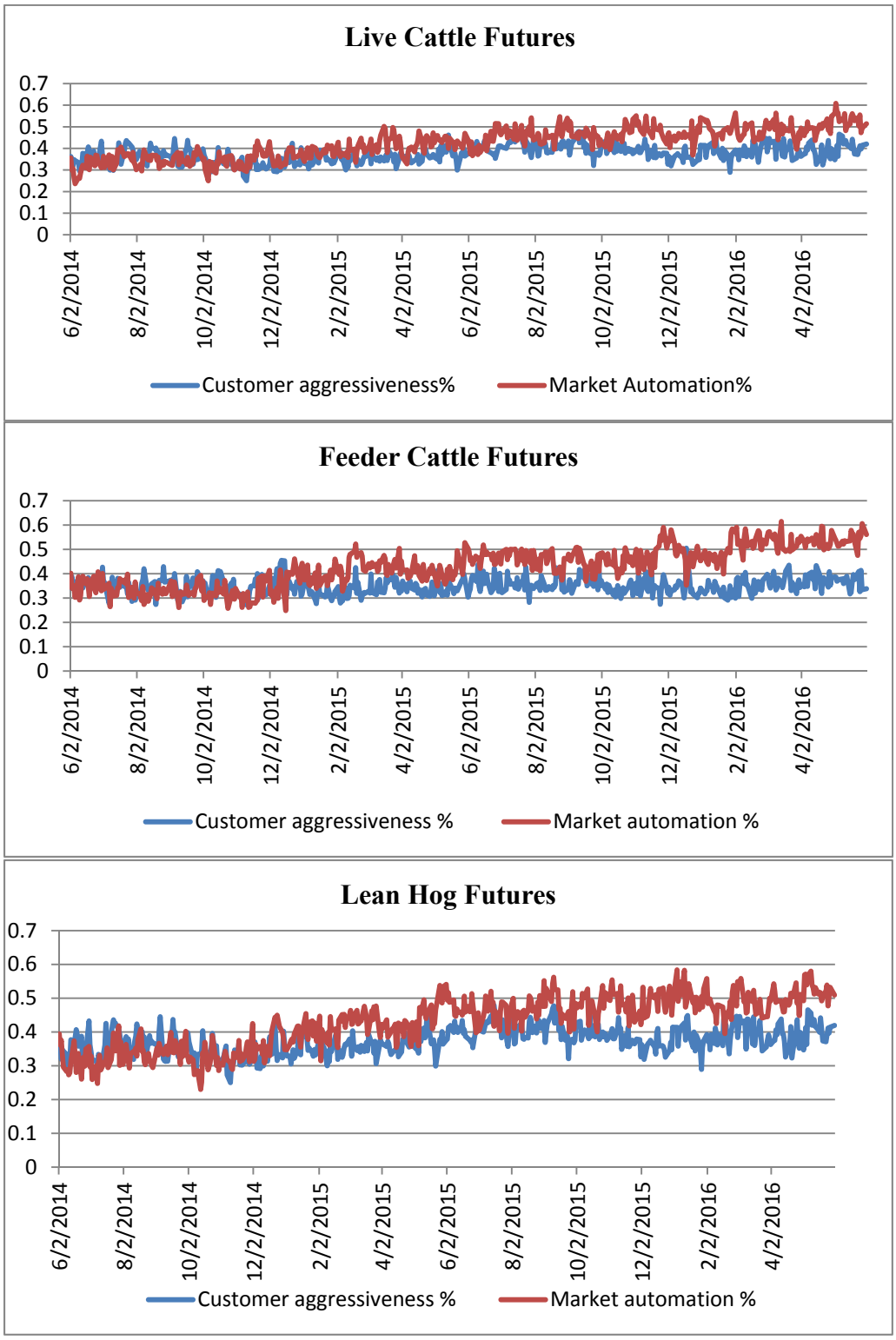


Figure 3: Effective half spread for customer aggressive and passive orders by commodity