THE BUZZ IN THE PITS: LIVESTOCK FUTURES' RESPONSE TO A RUMOR OF FOREIGN ANIMAL DISEASE

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INTRODUCTION

Foreign animal diseases such as foot-and-mouth disease (FMD) pose a significant threat to the US economy. Current policy in the event of an FMD outbreak involves high levels of slaughter reducing aggregate meat and livestock supply, international export market closures and trade barriers, and other significant sources of local and national revenue losses[1]. The last two sources of damages to the economy stretch beyond and often exceed the direct disease mitigation costs and value of animals lost. For example, lost revenue from tourism was the largest loss category in the 2001 UK FMD outbreak (UK National Accounting Office, 2002).

There is a considerable amount of uncertainty related to the threat of FMD since a confirmed incident has not occurred in the US since 1929. Uncertainty exists in the probability of disease occurrence, how fast it will spread, how quickly it will be contained and the magnitude of the impacts on demand and supply as well as the indirect costs relating to the disease outbreak. Given this uncertainty, the magnitude of damage to the economy is mostly unknown but is expected to be large. Livestock futures markets are shown to react quickly to confirmations of Bovine Spongiform Encephalopathy (BSE) discoveries in the US (Tse & Hackerd 2005; Jin et al. 2008). However, the level of response that is expected from a rumor of animal disease that is unconfirmed has not been addressed in the literature.

The purpose of this study is to examine the implied volatility, persistency and rationality of futures market reactions to animal disease information uncertainty. This is achieved using data

reflective of a widely publicized rumor of FMD based on a test performed at a Kansas sale barn in March 2002. This rumor that turned out be false 48 hours later. It led to plummeting market prices of cattle futures and a loss estimated at $50 million (Cupp et al., 2004). Furthermore, in an attempt to understand the nature of the price reaction to the shock, an examination of whether the market exhibits herding behavior and/or momentum trading is done. These behaviors could cause the reaction to be greater in magnitude or more persistent than would otherwise be expected. Examining the livestock futures contracts' movement in reaction to a disease rumor also provides insight into the dynamics of how traders will respond to information related to animal disease in the future.

The remainder of this paper will be organized as follows. First, an overview of the relevant literature on information uncertainty in the futures market, herding and momentum trading as well as its application to the current problem is presented followed by an overview of the FMD rumor in question. Next, futures price data will be used to examine the volatility, persistency and rationality of response to the rumor. Finally, general summary and conclusions are discussed as well as ways this study will be expanded in the future.

KEY LITERATURE ON INFORMATION UNCERTAINTY, HERDING AND MOMENTUM TRADING

Information uncertainty plays an important role in explaining futures market price and volume movements. Unscheduled announcements of news impacting markets lead to an increase in traders' uncertainty about future prices (Ederington & Lee, 1996). This in turn causes an increase in the implied volatility of the stock. However, the traders' reaction to news may not be irrational. It is a specific type of information uncertainty that leads to over or under-reaction by traders. Avery and Zemsky (1998) explore the role of information in herding behavior. There

are three types of information uncertainty that impact the level and duration of a shock in the futures market: value uncertainty about how the asset value will change, event uncertainty about the existence of event, and composition uncertainty on accuracy of information received. In the case of the FMD rumor, the value uncertainty is the lack of nearby precedent. Since the last FMD case in the US dates back to 1929, there is no recent example for how futures markets would be expected to react. The event uncertainty pertains to whether the test would be negative for at least some parties involved. The composition uncertainty may exists due to media speculations and rumors about the event. If both the value and composition uncertainties exist, then herding behavior may occur; however, when the composition uncertainty exists the herding behavior may lead to significant short term price distortions. This is because traders will have a "mistaken but rational belief that most traders possess very accurate information" (Avery & Zemsky, 1998).

Herding behavior has been given several definitions that primarily differ in whether agents involved move simultaneously or sequentially. Most authors have defined herding as the simultaneous trend of agents to move into and out of a market/asset rather than follow their own beliefs and information (Lakonishok, Shleifer & Vishny, 1992; Avery & Zemsky, 1998; Hwang & Salmon, 2004; Tse & Hackard, 2005; Baur, 2006; Walter & Weber, 2006). Others have pointed out that the trades occur sequentially since traders cannot buy and sell at the exact same time; someone must move first. These authors define herding as agents following each other into and out of a market/asset *over some period of time* rather than following their own beliefs and information (Nofsinger & Sias, 1999; Sias, 2004; Agudo, Santo, &Vicente, 2008; Lin & Swanson, 2008). This study applies the later definition of herding.

Herding behavior has a rich theoretical and empirical literature. While the former has provided considerable plausibility for the existence of herding, the evidence of herding is mixed. The theoretical literature on herding applicable to this problem focuses on a situation where traders' information is positively, cross-sectionally correlated (Froot, Scharfstein & Stein, 1992; Hirshleifer, Surahmanyam & Titman, 1994) and herding behavior is irrational (Lakonishok et al. 1992; Walter & Weber, 2006). This will occur in the context of "event related" herding where traders tend to move together in order to offset extreme volatility or uncertainty about the market in the future based on some event (Lin & Swanson, 2008).

Empirical work on herding has focused on specific stocks/securities/funds with mixed results. Herding behavior is empirically detected among foreign investors moving into and out of the U.S. markets (Lin & Swanson, 2008), investors in both Chinese A shares and Chinese B shares, especially among Chinese domestic investors (Tan et al., 2008), investors in German mutual funds (Walter & Weber, 2006), Spanish equity funds ((Agudo, Santo & Vicente, 2008) and Taiwan securities (Chen, Wang & Lin, 2008) . Chang, Cheng and Khorana (2000), who find herding in Taiwan and South Korea as well as a small amount in Japan, conclude that herding would be more likely in emerging markets as no evidence of herding was found in the US or Hong Kong equity markets. Experience also appears to factor into the tendency to herd, where more experienced fund managers have a lower tendency to herd (Menkhoff, Schmidt & Brozynski, 2006). Alternatively, Wermers (1999) finds little evidence of herding in mutual fund managers and Gleason. Mathur and Peterson (2004) find no evidence of herding among exchange traded funds. Herding during large scale extreme events like the Asian financial crisis has received no support from the literature (Baur, 2006).

This study will specifically define herding as the tendency of futures traders to buy (sell) futures contracts over some period of time based on the actions of other traders rather than on any private information about the disease shock. This has several implications, particularly that some traders will obtain information before others giving them an advantage. Several studies have concluded that it is obtaining information early, rather than the accuracy of that information, that yields higher returns for a trader (Froot, Scharfstein & Stein, 1992; Hirshleifer, Surahmanyam & Titman, 1994; Avery & Zemsky, 1998). Huberman and Regev (2001) find evidence of herding when positive information became widely available, even though that information was previously available through scholarly publications. They posit that traders acted on noise trader behavior rather than expert opinion information made available five months earlier.

One would expect, once the information uncertainty is cleared up (meaning a negative test is reported) that mispricing should stop and prices should recover. In fact Tse and Hackard (2005) note that "once the market maker learns about event uncertainty and allows prices to adjust, herding disappears". Hong and Stein (1999) note another market behavior called momentum trading that could help explain any continued drop after the news of the negative test was publicized.

Following the assumptions of Hong and Stein (1999), consider two types of traders: "newswatchers" that do not condition on current or past information in making their forecasts and "momentum traders" who rely on information from previous trades to set price forecasts. Both types of traders are boundedly rational--meaning they cannot observe all information perfectly and do not have unlimited computational capacity--and both make forecasts based on signals they privately observe on fundamentals. The difference is in the use of information and

conditioning on past trades. Momentum trading means investors follow their own lagged trades (Sias, 2004). Hong and Stein (1999) conclude that newswatchers may under-react to new information, but will never overreact if they alone are in the market. However, when momentum traders enter the market they will try to profit from newswatchers' under-reaction resulting in an eventual overreaction as more momentum traders try to take advantage of the opportunity. As a result, early momentum traders can make money but they impose a negative externality on later momentum traders who lose money.

Momentum trading may occur simultaneously with herding behavior. For the purposes of this paper, this indicates a tendency of futures traders to buy (sell) futures contracts over some period of time based on the actions of other traders and lagged returns rather than on any private information about the disease shock. Although the Hong and Stein model is primarily theoretical, Sias (2004) and Tse and Hackard (2005) offer empirical applications of momentum trading in conjunction with herding analysis. Both find evidence of momentum trading and herding. Sias (2004) notes however that even when investors are momentum traders this does not necessarily explain a great deal of herding behavior.

The work on futures markets' reaction to an incident of animal disease is sparse in the literature. U.S. live cattle futures prices were found to be negatively affected by BSE cases in the UK (Paiva, 2003) and by the 2003 U.S. BSE case (Schlenker & Villas-Boas, 2008; Jin et al. 2008). However, all these studies are based on a confirmed case of animal disease. No studies have been done to determine whether strong rumors of animal disease will affect livestock futures markets and whether such rumors will trigger herding and momentum trading. Furthermore, no studies have been done specifically for FMD, which has certain characteristics quite different from BSE (e.g. FMD cannot be transmitted to humans). Huberman and Regev

(2001) suggest that it is possible that traders in the livestock futures pits could trade based on rumor noise rather than waiting for an official announcement, which makes investigation on the reaction of futures markets to rumors of animal disease relevant and important. This study focuses in particular on one case of an FMD test in Holton, Kansas.

BACKGROUND ON FOOT AND MOUTH DISEASE RUMORS

In 2004, there were 689 tests for vesicular diseases (which includes FMD) done in the US (USDA-APHIS, 2005). The reason so many tests are performed is that the physical manifestations of disease symptoms are very similar to other, more benign mouth problems caused by burrs and mold in feed. However, if news media reports a particular test widely it can be mistaken as a sign that FMD has been found in the country.

There have been three US cases when tests were widely publicized and a reaction allegedly occurred in the livestock futures, including: a March 28, 2001 test on six hogs at a slaughter facility in North Carolina; a March 16, 2001 test on cattle at a sale yard in Idaho; and a March 2002 test on 9 cattle at a sale barn in Kansas. However, for the first two cases the impacts of the test-related publicity on livestock futures were confound by extraneous but relevant events. In particular, the United Kingdom FMD outbreak started on February 20, 2001 and lasted until September 30, 2001. The Netherlands FMD outbreak occurred from March 21 to April 22, 2001. Around the same time there were outbreaks in France and Ireland as well. Even though market news reports claim livestock futures markets reacted to the tests in North Carolina and Idaho (DeCola, 2001; Cote & Thacker, 2002) and Idaho (Hedberg, 2001; Cote & Thacker, 2002), it may be very difficult to determine the true scope and length of the reaction given the other perturbations to the market from foreign events. This study focuses on the March, 2002 Kansas case.

On March 12, 2002 a veterinarian noticed and reported possible signs of FMD in a salebarn at Holton, Kansas. Upon further monitoring of the animals, the veterinarian felt confident this was likely not to be an FMD outbreak as evidenced by horses on the premise having similar symptoms (Cattle Buyers Weekly-1, 2002). Tests for FMD on nine cattle were immediately carried out on the same day, while the other 16 cattle still housed at the salebarn were quarantined between 6:30 and 7:00 pm on March 12th pending the results (Cattle Buyers Weekly-1, 2002). Since the tests and quarantine occurred after trading hours in Chicago it can be inferred that the rumor would not have affected trade on March 12th.

Exactly how and when on March 13th the rumor reached traders is uncertain, based largely on speculation in the newspapers. *Agweek* reports that by the morning of March 13th "an Iowa radio station was reporting the possibility of a foot-and-mouth outbreak in Kansas. Chicago traders heard the rumors and cattle markets nose-dived." (Hutchinson News, 2002). Another source speculates that the rumor was passed through word of mouth from a local cattle broker attending the sale to a broker working with traders in Chicago, and from there the trading floor (Corn, 2002). The general agreement of all news sources though is that some traders heard the rumor after trading hours on the 12th, but largely the rumor was circulated in the live cattle pits early in the trading day on March 13th. Such publicity allegedly was the cause when live cattle April futures limited down dropping 1.12 cents to 74.50 cents a pound (Cote & Thacker, 2002) as traders swiftly responded to the information. The markets then recovered slightly by the end of the trading day. A *Wall Street Journal* article published on March 14 quoted floor trader Jim Rose with R.J. O'Brien and Associates as saying, "If the preliminary results are negative, we should have a sharp rally" (Cote & Thacker, 2002).

Negative results for the tests were reported by the evening of March 13th. However, instead of “a sharp rally”, prices dropped once again on Thursday morning, March 14. Traders continued to sell resulting in live cattle futures falling the limit on the 14th, dropping 1.3 cents to a two month low of $73.20 cents per pound (Cote, 2002). By the end of the day, prices were trending slowly back up in response to the negative test result.

It is possible that a trader or small group of traders manipulated the market to make a greater profit from the trade. Since prices in cattle futures are expected to plunge should a FMD outbreak occur, traders that have a short position could potentially have made quite a bit of money out of the rumor. The National Cattlemen's Beef Association (Bloomberg News, 2002) and the Kansas State Attorney General (Milburn, 2002) demanded an investigation. One was performed but failed to provide solid evidence of manipulation (Cattle Buyers Weekly-3, 2002). Futures Trading Commission chairman James Newsom made a public statement concerning the investigation on the events around March 13th, "We have found no deliberate activity of anyone to try and manipulate those markets. We didn't see any aggregated net positions that were of a big surprise to us." (Bloomberg News, 2002). Thus we are left with the idea that traders did not necessarily manipulate the situation knowingly, and so they must have felt their movement in the market was appropriate given the information available to them.

DATA

To examine the fallout from the rumor, four meat commodities were used: live cattle, feeder cattle, lean hogs and pork bellies. Live cattle are animals that have reached their mature slaughter weight and are about to enter the food chain. Feeder cattle are lighter weight cattle that will likely enter the feedlots, but are not yet ready to slaughter. It is expected that live cattle futures prices will be more sensitive to information than could be considered by consumers and foreign

markets as threatening to the safety of the meat product. Since FMD is contagious to swine, two swine/pork futures contracts are also examined. Lean hogs are swine that have reached their mature slaughter weight and are about to enter the food chain. Pork bellies are the only post-slaughter livestock futures contract considered here.

Futures intra-day transaction data was obtained from the Chicago Mercantile Exchange (CME) on live cattle, feeder cattle, lean hogs and pork bellies for all futures contracts trading between February 28, 2002 and March 27, 2002. Observations are on the futures price at a given day and time for every contract traded in that month. In order to get a broader viewpoint on the incident, daily data was also collected from Datastream© through the Texas A&M Library Services. Daily data included settlement price, daily open, daily close, daily high and low as well as volume traded on futures contracts of the four livestock commodities for the period of January 1st, 1988 to December 31st, 2002[2]. The daily dataset is spliced such that the information listed is for the nearest futures contract; the transition from one futures contract to the next is made upon the current nearest contract reaching maturity.

EMPIRICAL ANALYSIS AND RESULTS

This section is split into two parts -- a clinical analysis in the style of Tse and Hackard (2005) and an econometric expansion to more fully quantify the impacts of the rumor.

Clinical Analysis

Table I presents summary statistics for the daily data series divided into three time periods: pre-event from 1 October, 2001 to 27 February, 2002; event-window from 28 February to 28 March, 2002; and post-event from 29 March to 31 December, 2002. [2] The results in Table I show that the average settlement price was higher and the average daily trading volume was greater in the event periods than that in the pre- and post-event periods for all four commodities except that

feeder cattle contracts on average had a highest price in the pre-event periods compared with other periods. However, the movement of daily settlement prices may cover the true intra-day price movement if the market has a great reaction but recovers by the end of the trading day. Furthermore, livestock cycles, seasonality, and price trends may play roles in the price comparison between three periods. To better understand the price movement possibly related to the FMD rumor, we use both daily and minute data on futures contracts for the event window and expand the clinic analysis in finer details.

Figure 1 plots movement of prices, rate of returns, and volume of futures contracts on feeder cattle, live cattle, pork bellies, and lean hogs during the event-window period (February 28 to March 27, 2002). The price volatility can be indicated by the daily high/ low price range given by the solid vertical lines and by the standard deviation of intra-day prices based on the minute data represented by dashed lines with triangles. The direction and level of price movements is indicated by the daily average prices based on the minute data and the rate of returns based on the daily settlement prices. Lean hogs futures contracts show the most volatility in prices, followed by pork bellies and live cattle, while feeder cattle contracts show the least. All four markets seem to move together during the period in which the rumor occurred; however, pork bellies seem to be less correlated than the other three commodities. In feeder cattle and lean hogs, returns fell post-rumor but recovered to previous returns levels by the end of the 14th. Prices in these two markets continue to trend down after the rumor, although this could be reflective of the gradual decline in prices that typically occurs during mid to late March. The reaction in the live cattle market is more persistent, with returns not recovering to pre-rumor levels until the 18th of March. Pork bellies on the contrary see increasing rates of returns during the 13th, but fell on the 14th and stayed low until the 19th. This may reflect a lag in the reaction

in the pork bellies market, which could be explained either as momentum trading, a spillover effect, or non-event related volatility. The comparison on daily trading volumes suggests that the rumor as well as the negative test result trigger greater transactions in all types of futures contracts, especially in the cattle futures markets.

In all four markets a small spike in volume can be seen on March 13th and 14th. In addition, all of the live animal contracts also show a drop in rate of return and price on these two days. This corresponds with the ex post reports that the rumor started circulating early in the trading day on the 13th. These patterns indicate the presence of herding behavior given the information uncertainty of the rumor and in particular the presence of composition uncertainty (Avery and Zemsky, 1998). In feeder cattle and lean hog futures there is an indication that rates of returns had started to fall prior to the rumor, which may be reflective of reports that feeder placements could be a potential explanation for the drop. An econometric analysis is conducted below to formally detect herding behavior. Momentum trading does not imply herding (Sias, 2004) but it may aggravate the effects of herding, so momentum trading is examined separately

Momentum trading is defined as the tendency of investors to use information from the last period to make trades in this period. In the context of this study, momentum trading would be identified where the return in period t depends on the information received in the previous period ($t - 1$) rather than the current one. No measures of momentum trading given in the literature can be used here since they depend on observing the number of traders in the market; rather, momentum trading is examined here through clinical analysis of daily data.

The negative test results were returned on the evening of March 13th; recovery would be expected to start on March 14th. However from figure 1, the only market to show recovery in the

rates of return were the feeder cattle market. Live cattle and lean hog futures' rate of return fell lower for those days. A continued drop in returns would reflect the presence of momentum traders acting on the previous days' information and return trends rather than seeking the most current information; the negative test result announcement. Some live cattle and lean hog traders had not assimilated the new information, and were instead trying to take advantage of the previous days' trend. The traders who continue to drive the negative trend would then be momentum traders. Pork belly futures returns fell on the 14th as well, but they were not continuing a price decline rather starting a price decline. This may be more indicative of a spillover effect or natural volatility than momentum trading.

The clinical analysis gives motivation to further quantify the presence of market volatility and some persistency in response to the rumor as well as to formally explore herding behavior triggered by the rumor using econometric analyses. Such econometric analysis to a great extent will control for livestock cycles, seasonality, and price time trends allowing a better understanding of the price movements possibly related to the FMD rumor.

Econometric Analyses

The econometric analyses are split into two sections. The first explores the volatility and persistency of the reaction to the rumor using a vector error correction model (VECM). The second explores the evidence of herding behavior by adapting a herding measure used in prior studies to livestock futures trading.

Analysis of Persistency and Volatility of the Impacts using a VECM

Financial time series data often exhibits non-stationarity. Commonly used are the (Augmented) Dickey-Fuller (DF) tests and Philips-Perron (PP) test, which examines the null hypothesis of a

unit root against the alternative of a constant deterministic trend. An alternative is the Zviot and Andrews (ZA) unit root test, which allows for one possible structural shift in mean, trend, or both (Zivot and Andrews, 1992). If data is stationary in differences a VAR can be used to model the prices series. However, a VECM is more appropriate when the data also exhibits cointegration. The number of price series is denoted by *n* and the time period by *t*. Based on the Johansen's cointegrated vector autoregression (VAR) model with *k* lags (Johansen 1988), the data generating process of Y_t that is a *n*-by-1 vector of price series, can be modeled as a VECM with *k*-1 lags:

$$(1) \quad \Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \sum_{l=1}^{J} \theta_l D_l + e_t ,$$

where ΔY_t is a n-by-1 vector of futures commodity price differences, Y_{t-i} is the vector of lagged own futures commodity prices, Π is the n-by-n conintegration rank matrix, Γ is a n-by-n matrix of parameters on the lagged price differences, D_l is a set of seasonal dummy variables, and *e* is a n-by-1 vector of pricing innovations (Lütkepohl and Krätzig, 2004). The seasonal dummy variable accounts for the yearly production cycle influence on futures prices. It can also be noted that the parameter matrix Π can be further decomposed such that Π=αβ where betas contain the cointegrating equation and alphas the speed of adjustment (Lütkepohl and Krätzig, 2004). Each equation in the VECM is estimated using ordinary least squares (OLS).

There are at least two ways to determine the optimal lag length (*k*) and the rank of the cointegration vector (*r*). The conventional approach is to use system-based likelihood ratio (LR) tests to sequentially determine them in two steps. First, using information matrices to determine the lag length; and then use trace tests to determine the rank of cointegration vectors (Johansen,

1988). However, since the true model is rarely known this procedure may lead to model specification problems that ultimately involve trade-offs between model parsimony and fit (Wang and Bessler, 2005). Recently, "model selection" methods based on information criteria that simultaneously determine the optimal lag length and the cointergration rank have been proposed and implemented as an alternative to the conventional two-step procedure (Phillips and McFarland, 1997; Aznar and Salvador, 2002; and Baltagi and Wang, 2007). The system based approach is popular due to its sound theoretical basis, computational simplicity, and superior performance relative to some other estimators (Brüggemann and Lütkepohl, 2005). However, there are at least three advantages of the model selection method. First, it jointly estimates the cointegration rank and the optimal lag length in a VAR (Phillips, 1996). Second, the model selection method relieves researchers from the arbitrary choice of an appropriate significance level in contrast with formal hypothesis testing used in system-based LR tests. Third, Chao and Phillips (1999) and Wang and Bessler (2005) provide simulation evidence to show the model selection methods based on information criterion give at least as good fit as system-based LR tests. We cross validate the results on the optimal lag length and the cointegration rank using both methods.

As shown in Table II, all three unit root tests (DF, PP and ZA tests) fail to reject the null hypothesis that the futures prices in levels contain a unit root at the 5% level of significance for feeder cattle, pork bellies and lean hogs. The same tests are then applied to the first order differences of each prices series, whereby the unit root hypothesis is reject at the 1% level of significance. Therefore, the evidence suggests that daily settlement prices of futures contracts of feeder cattle, pork bellies, and lean hogs contain a unit root (they are nonstationary) in levels but

their first order differences are stationary. The only exception is live cattle, in which the level prices are stationary.

Based on Table III, it can be concluded that the optimal lag length is one and cointegraton rank is two using the conventional two-step procedure. Furthermore, the values of information criterion are fairly close between the lag length equals to 1, 2, 3, and 4. Based on the model section approach using Hannan and Quinn (HQ) information metric, the optimal lag length is two and the cointegration rank is three. Due to the advantages of the model selection approach, the final VECM is based on k = 2 and r = 3.

After fitting an appropriate VECM, examination of deviations of the forecasted prices from the actual prices is performed. These deviations quantify the size and persistency of the FMD rumor impact on the futures markets. Figure 2 plots the actual (line with squares) and forecasted (line with asterisks) prices of futures contracts during the event-window period. The difference between these two lines reflects the impact of the FMD rumor. Figure 2 shows that feeder cattle, lean hogs and particularly live cattle actual futures prices move significantly outside of the 90% confidence interval of forecasted prices. The movement out of the confidence interval on the 13th in the two cattle futures shows a quick response to the rumor in those commodities. Lean hogs did not track out of the confidence interval until the 15th. This could represent a lagged response to the rumor, potentially a spillover effect from the cattle futures markets [3]. Pork bellies stay within the 90% confidence interval. This market has historically more price volatility than the other three.

Figure 2 also illustrates the persistence of the shock as evidenced by prices continuing to remain below the 90% confidence interval. Actual prices do come close to moving back into the

interval for feeder cattle and lean hogs but live cattle have persistently low prices until the end of March. Overall, the results suggest that the FMD rumor statistically reduced the futures price of feeder cattle, live cattle, and lean hogs on March 13. The negative trend persisted on March 14th even though the negative test results came out. The incident may well have been a trigger for the downward price cycle earlier in the year than expected. However, the incident was not found to have a significant impact on prices of pork bellies contracts.

Analysis on Herding Behavior Resulting from the Rumor:

Econometric measures for herding have attempted to capture the patterns in the cross section of traders over time in order to examine whether they follow each other into trades (Sias, 2004). Several authors have proposed measures for quantifying herding behavior (Lakonishok, Shleifer & Vishny,1992; Christie & Huang, 1995; Sias, 2004). The Lakonishok, Shleifer and Visney (1992) and Sias (2004) herding measures were designed to track how many investors bought or sold in a particular security.

Data on how many traders were buying (selling) during the event window is unavailable, thus our examination of herding will focus on herding behavior as measured by a negative association between dispersion of returns (e.g. standard deviations) and position in the distribution of extreme returns.. Recall that herding implies reduced levels of return dispersions as traders move together in a particular direction during times of market stress. By looking at the tails of the distribution--reflecting the focus on periods of market stress--this measure of herding focuses on whether traders exhibit rational behavior (higher dispersions) or herding behavior (lower dispersion). This follows the methodology for measuring herding proposed by Christie and Huang (1995), which is concerned with whether or not individual returns can indicate

herding during periods of market stress. Dispersion in this case is the average difference in the returns at a particular moment to the mean returns in the livestock futures market:

$$(2)\quad S = \sqrt{\frac{\sum_{t=1}^{T}(r_t - \bar{r})^2}{T-1}},$$

where r_t is the observed return based on at the minute data within day t and the daily average return is denoted by $\bar{r}$. However, as Christie and Huang (1995) point out low dispersions by themselves do not guarantee the presence of herding. To examine whether herding has occurred, the extreme tail levels of dispersion are identified by using the following regression:

$$(3)\quad S_t = \alpha + \beta_1 \cdot D_t^L + \beta_2 \cdot D_t^U + \varepsilon_t,$$

where the two dummy variables D_t^L and D_t^U indicate whether the daily return lies in the lower or upper tails of the distribution. The constant α represents the average dispersion of the sample except for the area covered by the two indicators. If the signs of β_1 and β_2 are positive, then the returns movements are consistent with rational behavior; however, if they are negative it is consistent with irrational herding behavior (Christie and Huang, 1995).

Zellner's seeming unrelated regression is used to detect herding behavior in the four commodity markets during the event period. The regression system consists of four equations for futures contracts of feeder cattle, live cattle, pork bellies, and lean hogs. In the equation for each commodity, the dummy variables D_t^L and D_t^U equals one if the daily rate of returns falls into the one or 99 percentile in its distribution. The statistic of the Breusch-Pagan test of independence (11.43) exceeds the critical value of the chi-distribution with six degrees of freedom (10.64) at the 10% significance level (see the last row in table 4). The Breusch-Pagan test suggests that the

SUR is appropriate since the variance of error terms exhibits heteroskedasicity. The results presented in Table IV suggest that herding behavior exists when the rate of returns falls in the low tail of the distribution for feeder cattle, live cattle, and lean hogs futures but it is only statistically significant for live cattle and lean hogs at the 10% significance level.. Furthermore, asymmetric patterns of herding behavior are observed in livestock futures markets across different commodities as well as comparing between the rate of returns in the lower and upper tails.

CONCLUSIONS AND LIMITATIONS:

Both the confirmation and/or rumor of a foreign animal disease pose a significant threat to US agriculture. A rumor of FMD introduces non-trivial information uncertainty into the livestock futures market. This uncertainty can lead to changes in prices and price volatility, as well as trigger herding behavior and momentum trading. Although many tests for vesicular diseases are done in the US each year, tests done on March 12, 2002 in Holton, Kansas had an impact on futures prices in feeder cattle, live cattle and lean hog contracts on March 13th as well as March 14th, despite the fact that negative test results were announced before start of trade on March 14th. Prices did rebounded near the end of the trading day, indicating the test results information had been assimilated. After the fact, an investigation was conducted that concluded no undue manipulation had occurred so an alternative explanation for the price impact is needed.

This study examined the persistency and volatility of the futures price of livestock commodities impacted by FMD: feeder cattle, live cattle, pork bellies and lean hogs. Lean hog and pork belly contracts showed the most volatility, but little persistence. Live cattle and feeder cattle had lower levels of volatility, but while feeder cattle recovered within a week live cattle took much longer. This study proposes the existence of herding behavior and momentum trading

on the part of livestock futures traders during this period contributed to the rumor price shock. Clinical analysis would seem to reveal herding behavior in feeder cattle, live cattle and lean hog livestock futures and momentum trading for live cattle and lean hog livestock futures. A more formal econometric analysis of herding behavior leads to evidence of herding behavior in live cattle and lean hogs.

The occurrence of herding behavior and momentum trading could be reflective of the nature of FMD and the expected response should the test be positive. FMD does not contaminate meat products; they are still fit for human consumption. There are still the restrictions put in place by international trade but domestic consumption is still possible so the impacts in pork belly contracts is more likely to be small compared to live animals. Information uncertainty may have been greater for live animal contracts for several reasons. The current stamp out policy would lead to mass slaughter of live animals coming in either direct or indirect contact with a disease carrier. This means any live animal at the time of the positive FMD test could be placed under immediate quarantine, slaughtered and the carcass disposed of. Thus the evidence of herding and momentum trading in live cattle and lean hogs particularly--since they are the closest to slaughter and therefore have the greater value--may be a reasonable conclusion given information uncertainty related to the FMD rumor. Although not significant in the econometric analysis, feeder cattle also showed clinical evidence of herding. As previously stated, momentum trading can lead to an over-reaction because of information uncertainty. The conjunction of herding behavior and momentum trading evidence for live cattle and lean hog futures could explain the large price and rate of returns drop observed during the event window and the persistency of the shock.

There are other possible explanations for a price decline in live cattle during this period: lower than expected cash live cattle trade, a slight drop in box beef values, speculation and feedlot placements. It could be argued that the rumor of FMD gave traders a reason to sell; however, even if the market was primed for a seasonal downturn the rumor appears to have caused the downturn to be steeper than expected or reasonable under ordinary circumstances. Herding and momentum trading provide plausible explanations for the over-reaction that occurred.

This analysis is by no means comprehensive. It is intended to serve as a starting point for further expansion to explore information uncertainty, herding and momentum trading in the context of animal disease. Ideally, future work would identify whether there is herding behavior in livestock futures markets in general, as well as whether and how the animal disease outbreaks or the rumors of them enhance or attenuate herding behavior. The small data sample limited the ability to test for herding and momentum trading more generally; a further analysis based on a year of minute data rather than a month will help us better identify whether there is a tendency toward herding and momentum trading in livestock futures. Further analysis includes the examination of information spillover into related commodities like corn or soybeans contracts and the examination of other maturity months than the nearest one.

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Table I

Summary Statistics for Daily Data on the Nearest Futures Contract for Feeder Cattle, Live Cattle, Pork Bellies and Lean hogs

	Pre-event periods (N=108) (10/1/2001-2/28/2002)				Event-window periods (N=20) (2/28/2002-3/27/2002)				Post-even periods (N=199) (3/28/2002-12/31/2002)			
	Mean	std.	Min.	Max.	Mean	Std.	Min.	Max.	Mean	Std.	Min.	Max.
						Feeder cattle						
Settlement price	84.18	1.90	78.15	88.08	80.46	1.47	78.33	82.48	79.05	3.23	71.23	85.45
High price	84.54	1.90	78.95	88.50	81.06	1.36	78.73	82.88	79.47	3.12	72.73	85.60
Low price	83.72	1.92	78.15	87.85	80.27	1.50	78.10	82.40	78.61	3.30	69.85	85.15
Volume	2549	999	989	5803	3014	1102	750	5776	2206	969	78	6560
						Live cattle						
Settlement price	69.85	3.42	61.75	76.38	73.01	2.25	69.70	75.88	68.15	5.38	59.40	79.63
High price	70.18	3.37	62.30	76.53	73.70	2.13	70.08	76.08	68.49	5.25	60.35	79.90
Low	69.35	3.53	61.75	75.95	72.75	2.24	69.55	75.68	67.68	5.38	59.33	79.15
Volume	16483	5028	7870	32368	18717	7544	3620	33962	14911	4649	433	32952
						Pork bellies						
Settlement price	74.75	3.27	66.08	81.50	79.44	2.53	76.28	83.50	70.63	9.07	51.83	89.03
High price	75.59	3.14	67.05	82.95	80.50	2.48	77.00	84.20	71.46	8.86	54.40	89.35
Low price	73.70	3.23	64.93	80.60	78.77	2.38	75.75	82.40	69.40	8.96	51.83	88.50
volume	714	242	324	1595	705	262	263	1281	548	264	31	1200
						Lean hogs						
Settlement price	54.18	3.90	47.58	62.73	56.02	2.79	52.55	60.35	45.95	6.84	30.05	60.40
High price	54.62	3.86	47.85	62.80	56.64	2.67	52.88	60.43	46.60	6.85	30.20	61.10
Low price	53.59	3.97	46.70	61.85	55.73	2.78	52.30	59.70	45.34	6.88	29.40	60.10
volume	7059	2407	2390	16290	8184	2900	849	11611	7761	2541	204	17121

Table II

Tests for Non-Stationary of Daily Settlement Prices of Futures Contracts

	Dicky Fuller test		Philip-Perron test		Zivot Andrew test	
	Level	difference	Level	Difference	level	difference
Feeder cattle	-2.09	-59.49***	-2.07	-59.48***	-3.44	-24.78***
Live cattle	-3.90***	-60.44***	-3.93***	-60.44***	-6.07***	-60.47***
Pork bellies	-2.49	-58.62***	-2.59	-58.61***	-4.11	-25.10***
Lean hogs	-3.00	-59.48***	-3.02**	-59.46***	-3.91	-26.70***

The asterisks, ** and ***, indicate 5% and 1% significance levels, respectively. The critical value is -2.86 at the 5% significance level and -3.43 at the 1% level for both Dickey Fuller tests and Pillip Perron tests; and -4.80 at the 5% significance level and -5.43 at the 1% level for Zivot Andrews' test allowing one structural break at the unknown date.

Table III

Determining the Optimal Lag Length and the Cointegration Rank

System-based likelihood ratio approach				
Determine the optimal lag length of the underlying VAR (k)				
Lag length	Schwarz information Criterion (SIC)	Akaike information criterion (AIC)	Hannan and Quinn (HQ)	
$k = 0$	13.27	13.27	13.27	
$k = 1$	**-1.49**	**-.156**	**-1.53**	
$k = 2$	-1.40	-1.55	-1.49	
$k = 3$	-1.31	-1.53	-.144	
$k = 4$	-1.22	-1.51	-1.40	
Determine the cointegration rank ® using trace tests				
	$r = 0$	$r = 1$	$r = 2$	$r = 3$
Trace stat.	54.23	32.74	**12.72**	2.22
5% critical value	(47.21)	(29.68)	(15.41)	(3.76)
Simultaneously determine the optimal lag length (k) and the conintegration rank (r) using model selection methods based on HQ information criteria				
	$r = 1$	$r = 2$	$r = 3$	
$k = 1$	10375	10734	10726	
$k = 2$	10372	10733	**10724**	
$k = 3$	10743	10742	10734	
$k = 4$	10740	10739	10730	

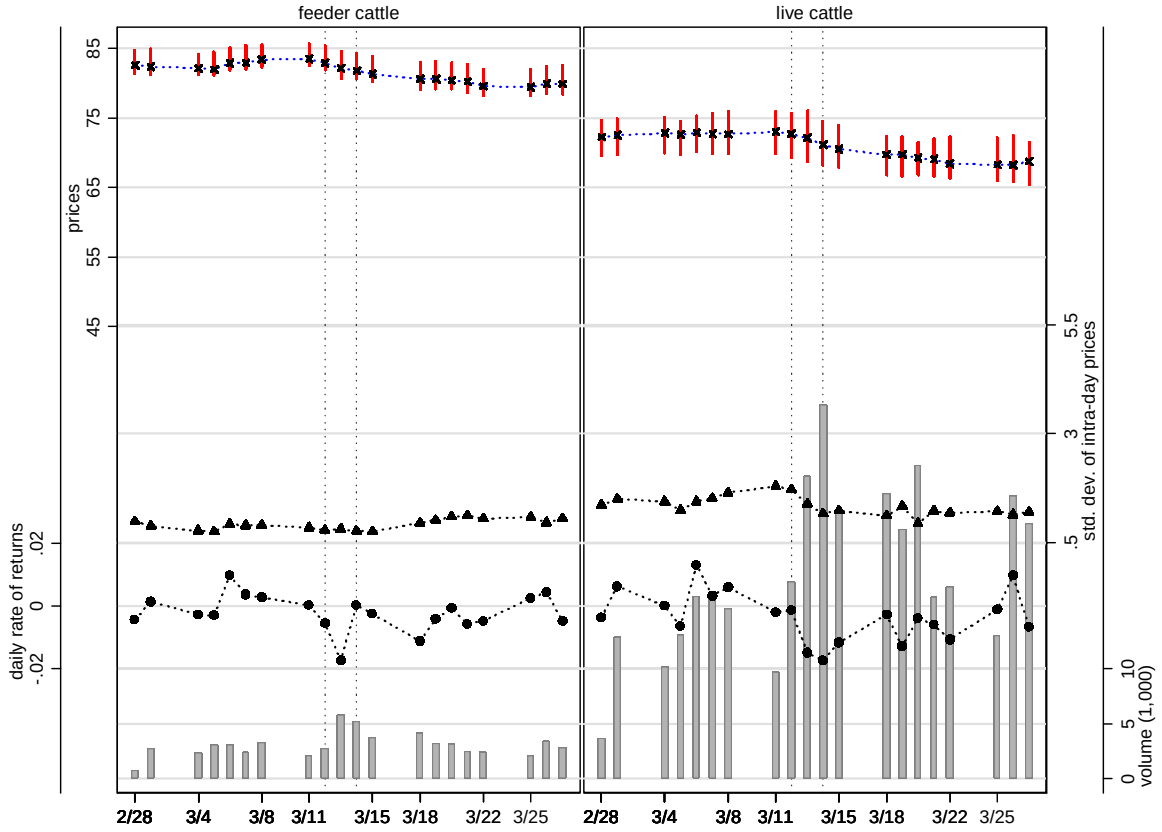
Table IV

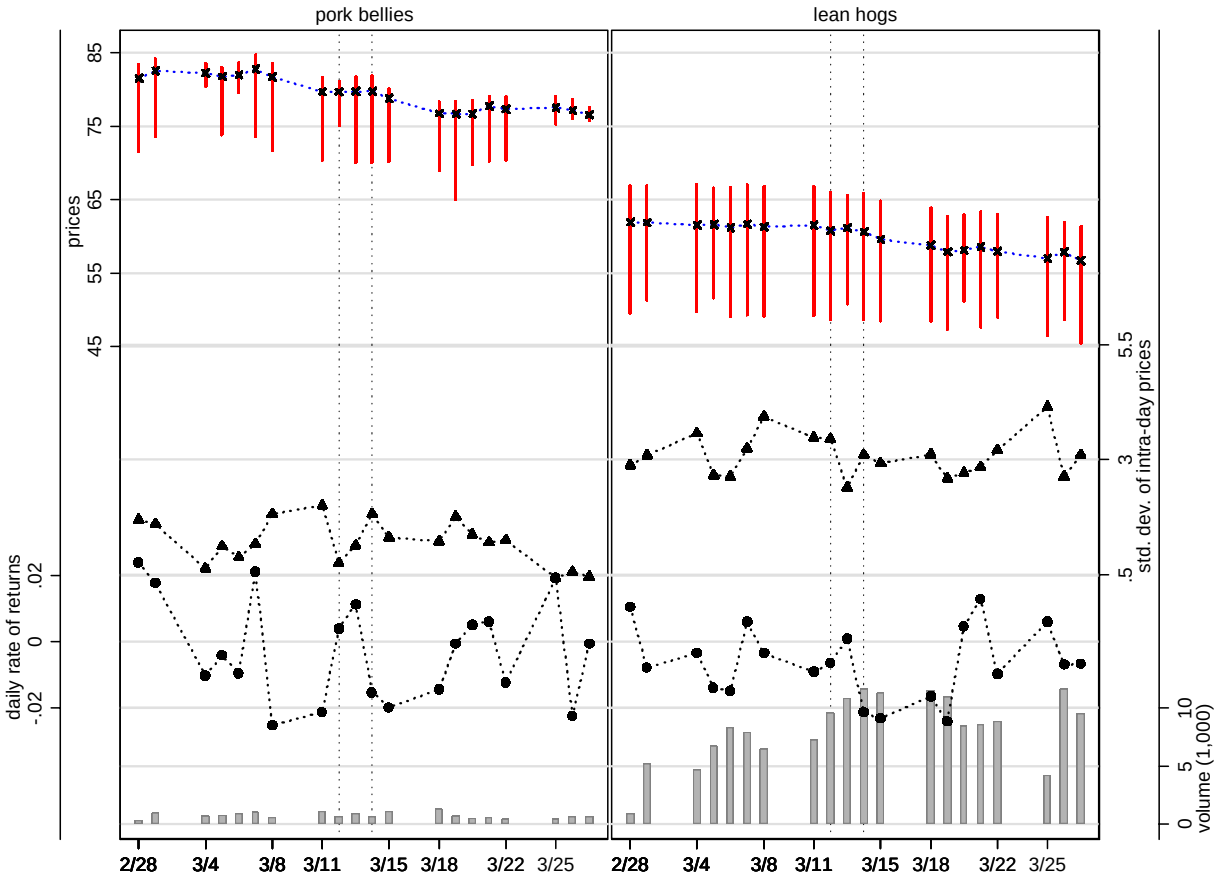
Zelner's Seemingly Unrelated Regression to Detect Herding Behavior during the Event Periods

Zelner's seemly unrelated regression of four equations				
	feeder cattle	live cattle	pork bellies	lean hogs
1 percentile of rate of returns	-0.001	-0.008***	0.003	-0.014*
	(0.002)	(0.002)	(0.006)	(0.007)
99 percentile of rate of returns	-0.001	0.001	0.004	-0.003
	(0.002)	(0.002)	(0.004)	(0.005)
Constant	0.013***	0.025***	0.014***	0.069***
	(0.001)	(0.001)	(0.002)	(0.002)
R-squared	0.03	0.01	0.08	0.10
No. of OBSs	20	20	20	20
Breusch-Pagan test of independence		chi2(6)=11.44	p-value = 0.08	

The asterisks *, ** and *** indicate 10%, 5% and 1% significance levels, respectively.

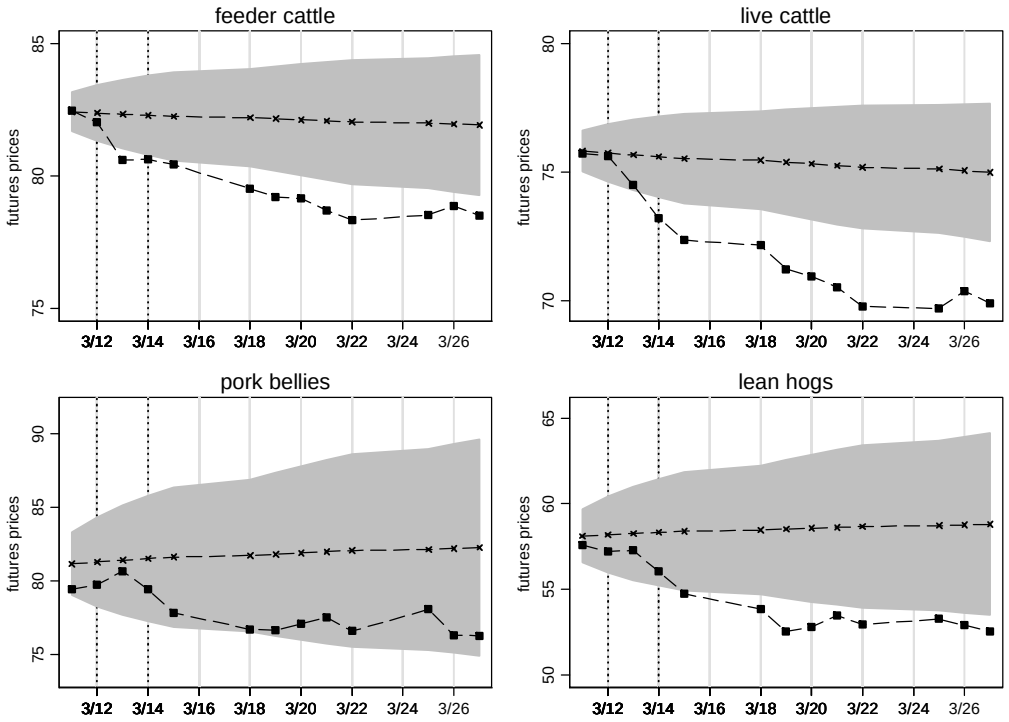
Figure 1. Price and volume movement of feeder cattle, live cattle, pork bellies, and lean hogs futures contracts during the event widow (2/28-3/27/2002)





Note. Price information consists of daily high and low prices (vertical lines for each trade day); daily average price (asterisks); standard deviation of intra-day prices (triangles); daily rate of returns based on daily settlement prices (squares); and daily trading volumes (vertical bars). Vertical dotted lines represent events dates of March 12th where the rumor of FMD diseases started to spread and March 14th when the negative results went public.

Figure 2. The impacts of the FMD rumor on future prices of feeder cattle, live cattle, pork bellies and lean hogs



Note. The shaded area represents the confidence interval of the forecasted settlement prices of futures contracts at the 10% significance level. The dashed lines with stars and squares indicate the forecasted and actual settlement prices.

[1] It is possible that a there could be a shift in domestic demand for meat upon confirmation of an FMD outbreak, but a study from the 2001 UK event has shown the demand reaction to be small in magnitude and short in duration (Chopra and Bessler, 2005) and work done on meat recalls have shown that medium sized beef and pork recalls only have a marginally negative impact on futures prices where results are not robust across recall size and severity (Lusk and Schroeder, 2000).

[2] Although we have daily futures prices dated back to January 1st, 1988, we present the summary statistics by pre- and post-event periods as well as event window periods starting from October 1st, 2001 and ending on December 31, 2002. The reasons to choose such dates are as follows. The UK FMD outbreak with a massive slaughter and media coverage started on February 20, 2001 and lasted until September 30, 2001 (NAO, 2002). Canada confirmed its first endemic BSE case on May 20, 2003. However, the preceding media speculation of the infected cow's diagnosis started in January (Tse and Hackard 2006; Highplain Midwest Agriculture Journal 2004). Thus, we truncate the daily data at both ends.