Price and volume relationship in the U.S. livestock futures markets

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Supervisor: Dimitrios Panagiotou

A thesis submitted in fulfillment of the requirements for the degree of

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Contents

Abstract

The objective of this work is to examine the relationship between closing prices and trading volume in the livestock futures markets of lean hogs, live cattle and feeder cattle. The parametric quantile regressions methodology is employed. Daily data between 1/1/2010 and 31/7/2019 were utilized. Findings suggest that the relationship between the two variables is non-linear. Price-volume relationship is positive (negative) under positive (negative) returns. Furthermore, co-movement is weaker at the lower quantiles and stronger at the higher quantiles. Results are in line with the empirical findings of the price-volume relationship in six agricultural futures markets from the study by Fousekis and Tzaferi (2019). This is the first study that utilizes the parametric quantile regressions method in the livestock futures market, in order to examine the returns-volume dependence.

Keywords: Livestock futures; Quantiles regression; Trading Volume; Prices; Co-movement.

JEL classification: Q14; G12; C13

1 Introduction

It is very important to connect fields in economics. Especially when finance combined with the agricultural economics. So it is interesting to seek the correlation and the volatility transmission of those. The laws of microeconomics and agriculture economics too, in combination with finance provide useful information for the investors, researchers and politicians.

The objective of this thesis is to exhibit conclusions for the relationship between price and trading volume in the livestock futures markets. Specifically to find the volatility transmission ant the connection of price and volume for these markets. This thesis is useful for the investors, as buyers-sellers and hedgers-speculators. Also for the researchers for future research with parametric/ non-parametric copulas or parametric/ non-parametric regressions that capture non-linearities.

Therefore the objective is the presentation of price and volume relationship with quantile regression model, that offers flexibility to the researchers as it can capture non-linearities and seek how quantile regression fits in agricultural finance economics.

In the early 21st century the advent of the online trading systems led to heightened interest in commodities and futures. So, this brought new participants into the trading arena. Individuals and investment companies poured millions of dollars into the commodities and futures markets. Since the first official commodity exchange began during the 1700s in Japan, the market for trading commodity contracts has grown to international proportions with exchanges on six continents.

Derivatives first traded in 2002 and introduced to the market by Deutsche Bank and Goldman Sachs. Providing hedges and speculation tools, the market for derivatives provided to economists with a richer and more clear picture of the consensus figures for the smart money on Wall Street. In 2007 the Chicago Mercantile Exchange (CME) shuttered derivatives action because of the low demand. The derivatives intent to transfer the risk of one to the other. Derivatives are either exchange-traded or over-the-counter (OTC). Over-the-counter (OTC) derivatives are contracts that are traded (and privately negotiated) directly between two parties, without other intermediary. Products such as swaps, forward rate agreements, exotic options – and other exotic derivatives – are almost always traded in this way. OTC commodities derivatives have higher risk but may also lead to higher profits.

Derivatives separated in futures contracts, forward contracts, options contracts and swaps. Contracts are the primary method of handling sales for many livestock commodities, like milk, hogs and in crops such as fruits, and processing tomatoes. Use of contracts is closely related to farm size; farms with $1 million or more in sales have nearly half their production under contract.

In addition a commodity market is a market that trades in the primary economic sector rather than manufactured products. Commodity includes all kinds of economics goods, like a movable property, money and securities. Is a basic good used in commerce that is interchangeable with other commodities of the same type. Commodities are most often used as inputs in the production of other goods or services. The three main areas of commodities are food, energy and metals. The most popular in food futures are for meat, wheat and sugar. In energy futures are for oil and gasoline and in metals are gold, silver and copper.

Investors have access almost in 50 major commodity markets worldwide. Futures are the oldest way of investing in commodities. The three types negotiation on the commodity market are futures, swaps and exchange-traded commodities where the investors interested for the returns of indexes.

Livestock futures and options provide the tools the industry needs to manage risk. The livestock market can expose the investors to risks that could affect profitability. Livestock also provide safety against the risk and is an economic buffer in some economies which may have problems with droughts, markets and other factors. It considered also as a diversification strategy.

At every stage of the livestock production chain, from birth to feeding, and processing to packing, market participants face the risk of adverse price movements caused by the twists of the market and supply and demand. Livestock futures and options provide a means to manage this risk as well as to take advantage of potential profit opportunities.

Livestock production plays a major economic and cultural role in many rural communities. The livestock industry is a global market, with livestock and meat being produced, processed and consumed. In developing countries, the livestock industry it is increasing because of the high demand for livestock products. In developed countries, demand for livestock products is stable, while the production is becoming more efficiency and environmental sustainability. Only the meat and poultry industry approximately offers 5.4 million jobs, $257 billion in wages and 527,019 people have jobs.

Moreover the beef industry is a global industry with an enormous economic impact. It considers as the basis of a multi billion-dollar industry worldwide. The United States has the 4th largest cattle inventory in the world in 2018 after India, Brazil and China and it is the world's largest beef producer. Beef production creates millions of jobs including suppliers, distributors and retailers. United States are the top cattle-producing nation in the world.

Cattle has many uses the most common are for food but many other by- products produced like liver, kidney, brains, tripe, sweetbreads and tongue are food sources in many countries. Also oleo oil and stock is an edible solid beef fat used to make some chewing gums and candies. Gelatin from cattle bone and skins is used to make marshmallows, ice cream, canned meats and desserts. Beef hide is used to make a variety of items: leather, felt, some textiles, base for ointments, binder for plaster and asphalt, base for insulation material, brushes, footballs. But also some industrial oils, lubricants, soaps, lipsticks, face creams, hand creams, chemicals, pesticides and detergents derive from beef fat products. And for buttons, piano keys, glues and fertilizers are some of the many products made from bones, horns and hooves of cattle.

The benefits of cattle market are facilitate price discovery and manage price risk, Arbitrage and spread opportunities with other commodities, Calendar Spread Options on Live Cattle futures, Transparent, deep liquid markets, Financial integrity of CME Clearing and Live Cattle: Physically delivered, Feeder Cattle: Cash-settled.

Live Cattle and Feeder Cattle futures and options serve commodity producers and users seeking risk management and hedging tools. Live Cattle are physically delivered contracts, while Feeder Cattle are cash-settled contracts.

The futures contracts on the regulated commodity exchanges are a way to get positioned to trade feeder cattle. Feeder Cattle futures contracts allow investor, to hedge in price between the time calves are born and when they are sold to feedlots. It also allows to hedge against an increase in the price of Feeder Cattle before the operator is ready to purchase them for their lot. For speculators with a limited amount of risk capital then feeder cattle options are a better way to invest in the feeder cattle market.

In the case of Feeder Cattle, the cattle raised for beef is the single largest part of American agriculture. The states with the bigger production are Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas and Wyoming.

Cattle are usually either steers (castrated males) or heifers (females that have not given birth). Cows (females that have given birth) and bulls (sexually intact males) generally are kept for production and not placed in feedlots. Once the feeder cattle reach the weight range of 1100 to 1400 pounds, they are considered live cattle. This means that they have reached the minimum weight for processing, and they are sold as live cows either directly to a packer or through an auction. Packers slaughter the live cows and sell all of the meat and by-products from the animals.

On the other hand, Live Cattle prices are very volatile and the futures contracts at that market are traded on the Chicago Mercantile Exchange (CME). They are the benchmark for world beef prices. Live Cattle futures are designed to allow to hedge against a decline in price before they are able to sell the cattle for processing, and for buyers, such as meat packers, to manage the risk of an increase in the price of the cattle they are planning to purchase for processing, or to protect their profit margin for beef they have committed to ship in the future. The seven major cattle producing states are Arizona, California, Colorado, Iowa, Kansas, Nebraska, and Texas.

Dairy cow is also a category in commodities with products as milk, butter, whey and cheese. The most common use is for milk production. California is the leader of milk of any U.S. state, with Holsteins cows to be the most productive. The factors that influence the choice of the breed are personal preference but also include characteristics like how much milk a cow will provide, the amount of fat and protein on average in the cow's milk and the temperament of the breed. In USA there are over three times more beef cows than milk cows. The last years the volume of milk where produced in the United States has been steadily increased.

Another important category of livestock commodities is hog. The U.S. pork industry is big business and risky, it affected by many factors as weather and disease. Lean hog futures and options traded at CME serve commodity producers and users seeking risk management and hedging tools, alongside funds and other traders looking to capitalize on the extraordinary opportunities these markets offer.

The benefits of this market are management of price risk and engagement in price discovery, access to electronic markets and arbitrage and spread opportunities with other commodities, such as grains.

Specifically, Lean Hogs in United States are produced mostly in Iowa, Minnesota, North Carolina and Illinois. Lean meat consists of an average of 21 percent ham, 20.3 percent loin, 13.9 percent belly, 3 percent spareribs, 7.3 percent Boston butt

roast and blade steaks, and 10.3 percent picnic. The rest goes into jowl, lean trim, fat and miscellaneous cuts and trimmings. Lean Hog futures allow investors, such hog producers and packers, to reduce the risk of price movements.

The major concentration of the market is at the slaughter and meat processing phase, with only four companies having 81 percent of cows, 73 percent of sheep, 57 percent of pigs and 50 percent of chickens. Through "forward contracts" and "marketing agreements", meatpackers are able to set the price of livestock long before they are ready for production. These strategies often cause farmers to lose money.

Finally there is another huge industry that it is based in livestock is the fast food. The meat that is used in those industries preferred for the low prices. The animals are treated with drugs and antibiotics so they can gain weight quickly and preventing disease. However, these animals suffer greatly because their internal organs and bones cannot keep up with the rapid increase in weight. There have been regulations implemented on fast food companies to restrict the usage of antibiotics. In 2018 only two fast food followed the rules.

So the present thesis appears to be the first that has considered the relationship between trading volume changes and changes in price returns in the livestock futures markets while allowing for non-linearities.

The empirical findings of the thesis exhibit asymmetric co-movement between price and trading volume for different quantile levels. More specifically, co-movement is stronger at the higher quantiles of the dependent variable than it is at lower quantiles, both under positive and negative rates of price returns. Furthermore, the intensity of co-movement, as expressed by the absolute value of slopes, increases as the level of quantile increases, both under positive and under negative price returns.

The pattern of co-movement is a possible U-shaped line with a potential flat section in the neighborhood of the low quantiles for the case of lean hogs. For the case of the futures contracts in the commodities of live cattle and feeder cattle, an asymmetric V-shaped line might capture better the relationship between the rates of change in closing prices and the rates of change in trading volume.

In what follows, section 2 presents the literature of review, section 3 presents data and descriptive statistics and section 4 the methodology. Section 5 presents the empirical model and the results. Section 6 offers conclusions.

2 Literature Review

Fousekis and Tzaferi (2019) investigate the strength, the pattern of co-movement in price returns and volume changes for six agricultural futures markets, in 2010 until 2018, with quantile regression. The pattern of co-movement is convex and the association is highly non-linear. It is positive for positive returns, except of the low quantiles of the conditional distribution of volume changes and vice versa.

Bassett Jr and Koenker (1978) propose quantile regression, a method to estimate conditional quantile functions. It is an extension of the techniques that uses the linear target function with minimal residuals to identify the optimal regression coefficients. The use of quantile regressions provides more flexibility. Without assumptions in the distribution, it is possible to produce different quantile regression

lines for the same sample. It also observe the relationship between the independent variable and the dependent variable in different quantiles to understand the overall distribution.

Koenker and Hallock (2001) indicate that the division of a sample may lead to the loss of useful information or even cause sample selection bias. Quantile regression techniques can avoid these problems. There are two statistical approaches to handling the problems associated with data distributions. The parametric, with specific assumptions on the distribution of a population and the non-parametric, where is no assumptions on the distribution of a population. Therefore, the median can be applied to different quantiles. Quantile regressions do not make any presumptions on the distribution of a population and the estimated parameters are based on the distribution of the original sample. Therefore, quantile regressions are a non-parametric approach.

Koenker and Bassett Jr (1978) examine the estimator which minimizes the sum of absolute residuals. Some equivariance properties and the joint asymptotic distribution of regression quantiles are established. So the generalization of the linear model of certain robust estimators of location done. The estimators have comparable efficiency to least squares for Gaussian linear models while out-performing the least-squares estimator over a wide class of non-Gaussian error distributions.

Kim and Muller (2004) present the asymptotic properties of double-stage quantile regression estimators with random regressors, where the first stage is based on quantile regressions with the same quantile and the second stage ensures robustness of the estimation procedure. They derive invariance properties with respect to the reformulation of the dependent variable. They propose a consistent estimator of the variance–covariance matrix of the new estimator.

Kaditi and Nitsi (2010) are using the 2007 Farm Accountancy Data Network (FADN) for Greece, analysis shows that the distribution of efficiency scores is closer to normality when employing regression quantiles. So the government aimed at enhancing farms viability should be directed towards payments decoupled from output or prices, as well as rural development payments that affect productivity in a uniform way.

Yu and Moyeed (2001) shown how Bayesian inference may be undertaken in the context of quantile regression. It is based on the asymmetric Laplace distribution which makes the method robust and the Bayesian approach provides complete univariate and joint posterior distributions of parameters of interest. It also demonstrates that improper uniform priors for the unknown model parameters yield a proper joint posterior.

Canay (2011) provides a set of sufficient conditions that point identify a quantile regression model with fixed effects. He also proposes a simple transformation of the data that gets rid of the fixed effects under the assumption that these effects are location shifters. The new estimator is consistent and asymptotically normal as both n and T grow.

Yu et al. (2003) observe that quantile regression gives an approach to the statistical analysis of linear and non-linear response models. This method has strong links to regression, robustness and extreme value theory.

Firpo et al. (2009) propose a new regression method to evaluate the impact of

changes in the distribution of the explanatory variables on quantiles of the marginal distribution of an outcome variable. The method consists of running a regression of the influence function (RIF) of the unconditional quantile on the explanatory variables.

Machado and Mata (2005) propose quantile regression to decompose the changes in the wage distribution with several factors contributing to them. This methodology identify the sources of the increased wage inequality and decomposes the changes in the wage distribution, by discriminating between changes in the characteristics of the working population and changes in the returns to these characteristics. Moreover educational levels contributed to higher wage inequality.

Buchinsky (1998) approach a semi-parametric technique of quantile regression, concentrating on cross-section applications. He presents several alternative estimators for the covariance matrix, reviews the results for a sequence of quantile regression estimates and discusses testing procedures for homoskedasticity and symmetry of the error distribution.

Return distributions differ widely across different commodities, both in terms of tail fatness and skewness. In this paper Steen et al. (2015) outline the return characteristics of nineteen different commodity futures during the period 1992–2013. They evaluate the performance of two standard risk modeling approaches, RiskMetrics against a quantile regression approach. The findings strongly support that quantile regression outperforms these standard approaches in predicting value-at-risk for most commodities.

Melly (2005) examined the changes in US wage inequality between 1973-1989 with residuals account for only 20% of the explosion of inequality in the 80s. He proposed a semi parametric estimator of distribution functions which is based on the estimation of the conditional distribution by quantile regression. The conditional distribution is then integrated over the range of covariates. Counterfactual distributions can be estimated, allowing the decomposition of changes in distribution into coefficients, covariates and residuals.

Koenker and Xiao (2003) made an approach to the Durbin problem with a martingale transformation of the parametric empirical process suggested by Khmaladze (1981). It can be adapted to a wide variety of inference problems involving the quantile regression process. They suggest new tests of the location shift and location–scale shift models that underlie much of classical econometric inference. The methods are illustrated with a reanalysis of data on unemployment duration.

Coad and Rao (2008) relate innovation with the sales growth of high-tech firms. A firm, on average, experiences only modest growth. The returns to innovation are highly skewed and that growth rates distributions are heavy-tailed. So the best method to approach it is quantile regression and observed that innovation is of crucial importance for the biggest fast-growth firms.

Füss et al. (2010) examine the in- and out-of-sample performance of various VaR approaches for commodity futures investments which driven by continuous supply and demand shocks that lead to a time-varying volatility. Results suggest that dynamic VaR models such as the CAViaR and the GARCH-type VaR generally outperform traditional VaRs and incorporate the time-varying volatility of commodity returns which are sensitive to significant changes in the series of commodity returns.

Kesavan et al. (1992) with the Error Correction Model, investigate dynamics in farm-retail price relationships within a general framework. A specification based on monthly data for farm prices of both beef and pork and was found valid and appropriate for the study of farm-retail price linkages.

Badshah (2009) examines the phenomenon of asymmetric return-volatility with the adapted and robust volatility indices VIX, VXN, VDAX and VSTOXX, which affect the trading strategies, hedging portfolios, pricing, hedging volatility derivatives and risk management. He quantify the effects of positive and negative stock index returns at various quantiles of the implied volatility distribution. When the level of the volatility index increases, the negative asymmetric return-volatility relationship should be significantly more pronounced at upper quantiles of the IV distribution. Every volatility index and its corresponding stock market index has a negative and asymmetric return-volatility relationships. The asymmetry increases monotonically when moving to the uppermost quantile. The VIX volatility index presents the highest asymmetric return-volatility relationship, followed by the VSTOXX, VDAX and VXN volatility indices.

Wang and Chen (2016) examine the relationship between contract prices and trading volumes crude oil contracts on the New York Mercantile Exchange and brent crude oil contracts on the Intercontinental Exchange with quantile regression. The findings showed that the movement of prices and volumes is in the same direction when prices go up but in the opposite direction when prices go down. They estimate that the opposite movement of prices and volumes at the time of falling prices is bigger. So when the prices go up of futures contracts the trading volumes will rise and when the prices go down, the prices and trading volumes of crude oil futures contracts are negatively correlated.

Foster (1995) study the volume-volatility relationships in oil futures markets with the GMM technique to model that relationship contemporaneously. The findings are that the oil futures markets do not react directly to a price change. The trading volume does not change the volatility or the volume-volatility relationship. The illiquid or immature markets might suffer from some type of noise trading as price volatility is not explained directly by the flow of information.

Fousekis (2019) examines the co-movement between prices and volatility in the future markets for crude oil with non-parametric quantile regression in daily price returns and volatility changes from 2007 to 2018. The findings conclude in a negative and asymmetric relationship and the pricing of volatility is heavier for large changes and it is lighter for large positive changes. The co-movement appears to be in line with the theoretical postulates of fear, exuberance and loss aversion.

The linkages between output and input futures prices are important for risk management in the energy sector. Fousekis and Grigoriadis (2017) examine the co-movement between crude oil, heating oil, and reformulated gasoline futures prices with non-parametric and time-varying copulas. The results suggest that short-run co-movement is high, symmetric with respect to the sign of shocks, and asymmetric with respect to the size of them. In the long run, price co-movement becomes perfect, and the price interrelationships obey the Law of One Price.

de Nicola et al. (2016) examine the extent of co-movement among monthly commodity price returns and they focus on 11 major energy, agricultural and food

commodities for the period 1970–2013. The results showed that price returns of energy and agricultural commodities are highly correlated, stock market volatility is positively associated with correlation of price returns especially after 2007 and the increase in the degree of energy-agricultural commodities price co-movement in the cases of maize and soybean oil, which are important inputs in the production of bio-fuels.

Koirala et al. (2015) investigate correlation between agricultural commodity futures prices and energy futures prices. Results reveal that agricultural commodity and energy future prices are highly correlated and exhibit positive and significant relationship. Also an increase in energy price increases the price of agricultural commodities.

Ciner (2002) examines the relationship between volume and price changes for Tokyo commodity futures contracts of gold, platinum and rubber and use the GMM model. Ciner focused on the predictive power of volume and to the dynamic relationship between volume and returns. He conclude in a positive relation between volume and absolute returns and the volume conveys information about the magnitude of price changes, but not about the direction of price changes. Finally, the evidence does not suggest that there is no influential on daily price-volume relation in futures markets.

Chen et al. (2004) examine the relationship between returns and trading volume of four traded commodity futures contracts in China. Correlations are not significantly different from zero, and there is no linearly significant causality in price and volume. But there is causality from trading volume and returns in the copper futures market, but not in the copper futures market.

Cheng et al. (2014) study responses of commodity future prices and positions of various trader groups to changes of the CBOE Volatility Index (VIX) before and after the recent financial crisis. Financial traders reduced their net long positions during the crisis, whereas hedgers also reduced their net short positions as prices fell. This risk flow led to a change in the allocation of risk with hedgers holding more risk than they did previously.

Yang et al. (2001) examine in the long run the price performance of futures markets for storable and nonstorable commodities, allowing for the compounding factor of stochastic interest rates. They conclude that asset storability it may affect the bias of futures markets' estimates for future cash prices.

Routledge et al. (2000) develop an equilibrium model of the term structure of forward prices for storable commodities and for forward prices predict volatilities. The spot commodity has an embedded timing option that is absent in forward contracts. This option's value changes over time due to both endogenous inventory and exogenous transitory shocks to supply and demand.

Sarris (2009) conclude that the global food commodity markets are likely to stay volatile, until stocks are replenished, petroleum prices stabilize and the global financial crisis works itself out.

Tang and Xiong (2012) found that prices of non-energy commodity futures in the USA have become increasingly correlated with oil prices. With the financialization process, the price of an individual commodity is no longer determined only by supply and demand. But determined by the aggregate risk appetite for financial assets and

the investment behavior of diversified commodity index investors.

Baldi et al. (2011) show that breaks were observed at food commodity markets and relate to events that have affected the supply and demand of corn and soybeans for food and energy purposes. The sub-periods express different dynamics in the causal relationship between spot and futures prices. Futures markets react more quickly to new or unexpected information than spot market. However, in times of crisis and in price increase, for soybean case, the price discovery is more related to fundamental patterns.

Weatherly et al. (2010) attempt to determine how people would delay discount a number of different commodities and showed that are often discount differently. They suggest for the same domain of commodities that measuring delay discounting for one commodity will be predictive of how people discount other commodities only within that domain.

Lyson and Guptill (2004) examine factors and conditions associated with the growth of commodity agriculture and civic agriculture. The civic agriculture is associated with particular commodities and with specific social, economic and demographic characteristics of localities. On the other hand commodity agriculture, is more affected to the classic economic factors of production, namely, land, labor, and capital.

Georgiev (2001) examines the sources of potential return benefits including the impact of commodity volatility on convenience yield. He conclude that direct commodity investment can provide significant portfolio diversification benefits. Adding a commodity in a diversified portfolio of assets has been enhanced risk-adjusted performance. These benefits stem from the market forces such as unexpected inflation and the positive roll return in futures-based commodity investment in periods of high spot price volatility. Marshall et al. (2013) examine liquidity commonality in commodity futures markets. Using 16 commodities, as agricultural, energy, industrial metal, precious metal and livestock they show there is a strong systematic liquidity factor in commodities. There is no evidence of a consistent link between stock and commodity liquidity in general. Although energy commodities appear to provide a better hedge against other commodity families.

Bodie and Rosansky (1980) examine the rates of return on commodity futures contracts traded in the United States from 1950 to 1976 and compare them with the rates of return earned on stocks and bonds. The futures portfolio had a more positively skewed return distribution and it use for hedging against inflation. The results in the market portfolio of common stocks in the S&P 500 did not offer the minimum variance for the given mean return during that period. Only commodities like hogs and pork bellies did not show significant correlation with each other.

Irwin and Sanders (2010) analyze the impact of index and swap fund in agricultural and energy commodity futures markets. There is no statistically relationship between changes in index and swap fund positions and increased market volatility. The evidence were strongest for agricultural futures markets.

Kristoufek and Vosvrda (2014) analyze the market efficiency of 25 commodity futures. The most efficient commodities are heating oil, closely followed by WTI crude oil, cotton, wheat, and coffee. The least efficient are live cattle and feeder cattle. That happened because of the predictability of some commodity futures in

the short run, but in the long run they return to their fundamental price, which differs from the results found for stock indices.

Deaves and Krinsky (1995) suggest some commodity futures may for extended periods appear to have risk premiums. This is due to the fact that the backwardation commodities (live cattle, feeder cattle, live hogs, and orange juice)/contango commodities (heating oil, crude oil, lumber) commodities have tended to have real spot price trends that are positive/negative. As these commodities have revisited it is found that the livestock commodities are salient exceptions, except the orange juice.

Gorton and Rouwenhorst (2006) find that the risk premium on commodity futures is the same as that on stocks in that period and the returns are negatively correlated between commodity futures, stocks and bonds. That is becoming as a result of commodity futures' different behavior over a business cycle. Commodity futures are positively correlated with inflation, unexpected inflation, and changes in expected inflation.

Yang et al. (2001) examine the price of U.S futures markets for storable and non-storable commodities in the long run, allowing for the compounding factor of stochastic interest rates. The asset storability does not affect the existence of cointegration between cash and futures prices and the usefulness of future markets in predicting future cash prices. However, it may affect the magnitude of bias of futures markets' estimates for future cash prices.

The growth of biofuels production, particularly in the USA, the EU, and Brazil, has had important implications for the global livestock industry. Taheripour et al. (2011) investigate the impact of biofuels industry on the global livestock production. With the growth of this industry, the livestock production overseas reduced and there are consequences in livestock as well as crops, which influenced by the substituting for feedstuffs. The nonruminant production is cut more than ruminant livestock. Are expected to reduce coarse grains exports and increase imports of oilseeds, vegetable oils and the exports of processed feed materials.

Koontz et al. (1992) argued that futures contract prices for non-storable commodities, like live cattle and live hogs, follow a rational formation process. But those two markets support the rational price formation hypothesis, where prices for distant contracts reflect average costs of feeding.

Martin and Garcia (1981) tested the price performance of live cattle and hog futures with four hypothesis. Live cattle futures had inadequate forecasting performance for each hypothesis but live hog futures perform well for three hypotheses, except of economic conditions which were unstable. Hog futures provide better forecasts than lagged cash prices.

Leuthold and Hartmann (1981) tested the efficiency of the cattle, hog, and pork belly futures markets in forming expectations about future contracts cash prices. In some periods of time these contracts have not performed efficiently, while at other times they have performed efficiently. The hog market was less accurate in forward pricing than cattle and pork belly markets. But with current information for these commodities, the futures prices cannot accurately reflect subsequent.

Leuthold (1983) examines the relationships between open interest and variables measuring commercial activity for live cattle, live hogs, and feeder cattle. They

also seek for the level of speculation and how the prices behavior affected. So the futures contracts are viable only when attracts commercial interests and used with merchandising or hedging. Hedging risks associated with speculators who absorb them and provide in the market liquidity, risk capital, and interpret information.

Schroeder et al. (1990) examine futures market prices for live hogs, live cattle, and feeder cattle to economic information contained in the USDA livestock inventory reports. Those reports do not exert a persistent downward or upward influence on futures prices. With new information in the market, return variability will increase. There is less information for the live hog market because of the high variability relative to the cattle market. They observe the reaction of livestock futures prices to the release of the USDA quarterly Hogs and Pigs Reports and Cattle on Feed Reports. So livestock futures markets react to the information in the quarterly COF and Hogs and Pigs Reports. The increases in return suggest that the reports provide new information to market. In addition, the cattle markets absorb information from the less detailed monthly COF Reports.

Röös et al. (2017) estimate the global land use and greenhouse gas emissions, based on four livestock futures and with the scenarios which are further intensification of livestock systems, a transition to plant-based eating, a move towards artificial meat and dairy and a future in which livestock production is restricted to the use of ecological leftovers. Results show that without improvements in crop productivity or reductions on today's waste levels available cropland will only suffice if production of all protein currently supplied by animal foods is replaced by (hypothetical) artificial variants not requiring any land. The available cropland will suffice for all scenarios, but when current consumption patterns and livestock production based on feed from cropland, available cropland will not be enough.

St-Pierre et al. (2003) estimate economic losses sustained by major US livestock industries from heat stress in 48 states. Animal classes were dairy cows, dairy heifers, beef cows, finishing cattle, sows, market hogs, broilers, layers, and turkeys. The economic losses considered as decreased performance in production, increased mortality and decreased reproduction. Texas, California, Oklahoma, Nebraska, and North Carolina accounted for $728 million of annual losses, or 43% of total national losses. Findings point to a need for more energy and capital efficient heat abatement systems.

Delgado et al. (2001) invest the population growth, urbanization and income growth which increased the demand for food of animal origin. Healthy diet could improve the life of many rural poor, so the governments and industry must prepare with long-term policies and investments.

Thomson et al. (2004) propose an alternative, commodity-based approach for animal health and food safety standards, based on the fact that different commodities pose very different risks when it comes to the spread of human and animal pathogens. Developing and others countries with more focused commodity standards would improve access to international markets by credible and independent certification.

Tarawali et al. (2011) explore mixed crop livestock systems and their response to increasing demands for livestock products without compromising future livelihoods of the poor or the environment. Trajectory of intensification, the type of livestock

commodity and the changing economic circumstances may impacted the potential of smallholder farmers to address future milk and meat demands as livestock system transition. They manage the options with increasing productivity and mitigate greenhouse gases and the use of land and water. Important factors are technology, efficiency and innovative.

Li et al. (2008) describe the livestock production systems (systems are the grazing, mixed farming, and industrial systems) in China, their status and trends, driving factors, and major issues with profound impact. There is a rapid growth in consumption and production of livestock food products in China. The livestock production systems are degraded by overexploitation of these lands, increasing demand and competition for feed grain, environmental and public health risks associated with industrialized livestock production. These problems must solve with the proper policy and technological interventions.

There are barriers with the system for the certification of internationally traded animal commodities for the developing countries accessing high-value international markets. Thomson et al. (2006) identify inconsistencies with the process. They suggest ways to address that problem in some developing countries and argue that this could be of significant benefit in these regions and countries, but that a reliable and independent system of certification based on international standards is essential.

Ethiopia is Africa's largest livestock producer but some barriers like animal diseases have constrained market access. Rich et al. (2009) examine the feasibility of sanitary and phytosanitary system under a number of scenarios. They conclude that the system may not be viable for beef exports to Middle Eastern markets, with the binding constraint is high domestic input costs. Although Ethiopia's export competitiveness could enhance with investments in animal productivity and feed efficiency, it is possible the market access be prevented by the global beef markets.

Steinfeld et al. (2006) assessee for the cattle and buffaloes, goats and sheep, pigs and chickens livestock species the current status of livestock production systems, the drivers of global livestock production and the major trends in such production. Global drivers in this sector include economic growth and income, demographic and land use changes, dietary adjustments and technological change. Asia has the most rapid growth and structural change but the rate of change and direction of livestock development vary among world regions.

Naik and Leuthold (1988) examine in both cattle and hog markets the presence of basis risk, speculative component and expected maturity for nonstorable commodities. All three exist and hog markets showed seasonality. Flexibility explains price relationships for both cattle and hogs, where previously attributed to only feed prices.

Production and marketing contracts govern is 36 percent of the value of U.S. agricultural production. Based on MacDonald et al. (2004) producers can reduce income risks of price, production variability, ensure market access and provide higher returns. Processors and other buyers ensure the flow of products and to obtain differentiated products, traceability for health concerns and guarantee certain methods of production. Spot market has difficulty to accurate price for products geared to new consumer demands, like organic products. It is likely to explicit forms of vertical coordination, through contracts and processor ownership, for product quantity

and quality insurance.

Johnson et al. (2010) compare the support programs in EU and USA commodities. In mid-1980s, total farm support in the USA and EU has decreased as a share of total gross farm receipts. In general, support for commodity programs has decreased. However, support for non-commodity programs still accounts less than 1% of farm receipts. The support for such programs is slightly greater in the United States, for non-commodity programs accounts for less than 0.7% of receipts, than in the EU, where it accounts for less than 0.3% of receipts annually. However in terms of total spending, the EU provides more support, in aggregate, than does the United States for both production-based programs and non-commodity programs.

Increasing livestock product consumption in many Asian countries has been accompanied by growth in some countries' imports of feed grains for their domestic livestock sectors. Rae and Hertel (2000) assessed the impacts of technological catch-up in livestock production on trade in livestock and grains products among countries in the Asia-Pacific region. Are explored the consequences for regional and global trade in livestock and grains products.

Mu and McCarl (2011) examine possible expected climate adaptations in a U.S. land use and livestock context. Climate variables are reducing crop land and increasing pasture land. So the cropping land would be altered to livestock land under climate change. Furthermore, cattle stocking rate may increase along with more pasture land or less cattle inventory because of higher temperature.

Godfray et al. (2010) explore the factors that affect the demand for food, the trends in future food supply, the exogenous factors affecting the food system and the cross-cutting themes between 2010 and 2050. The advances in sustainable food production and availability can be achieved with the current technologies and the investing in research.

LI et al. (2012) studied how the price movements of pork, chicken and egg respond to those of related cost factors in short terms in Chinese market with a linear quantile approach to explore data heteroscedasticity and to generate confidence bands for the price stability study. They observed that price changes of cost factors influence those of the livestock across different quantiles. The performance is robust and consistent and the confidence intervals are good methods to forecast livestock price fluctuation.

Baldos and Hertel (2014) argue that, in the long run, food prices will most likely resume their historical downward trend. In 1961-2006 the growth in agricultural productivity outpaced that of global crop demand, so the global crop prices go down. The global crop prices will continue their long run decline in the coming decades with a slower pace, given expected developments in population, incomes, agricultural productivity and bio-fuel use.

Silvennoinen and Thorp (2013) estimate sudden and gradual changes in correlation between stocks, bonds and commodity futures returns driven by observable financial variables and time. In 1990s most correlations begin near zero but closer integration emerges around the early 2000s and during the recent crisis, the benefits to investors were significantly reduced. Increases in VIX and financial traders' short open interest raise futures returns volatility for many commodities. Higher VIX also increases commodity returns correlation with equity returns for about half the pairs, indicating closer integration.

In China livestock is becoming more important in the domestic agricultural economy. Rae et al. (2006) estimate the total factor productivity for four major livestock products employing the stochastic frontier approach, and decompose productivity growth into its technical efficiency and technical progress components. The results show that growth in total factor productivity and its components varied between the 1980s and the 1990s. Technical efficiency improvement has been relatively slow despite of considerable technical innovation in livestock.

Demand for livestock products have been driven by human population growth, income growth and urbanization. The production in livestock systems has been associated with science, technology and with increase in animal numbers. Thornton (2010) believes that in the future, production will increasingly by competition for natural resources, competition between food and feed and with the restriction of low carbon. Livestock production is increasingly affected by carbon constraints and environmental and animal welfare legislation. However, the demand for livestock products in the future could moderated by human health concerns and changing socio-cultural values.

3 Data and Descriptive Statistics

Data are daily closing prices and trading volume from contracts of front month futures from the livestock commodities of lean hogs, live cattle and feeder cattle. The time period under investigation is between 1/1/2010 and 31/7/2019. Data were collected from Quandl.

Figures 1-6 present the evolution of the natural logarithms of prices and volumes. The price time series generally exhibit upward trends for the period 2010-2015 and downward trends after 2015. The volume time series exhibit significant volatility without any upward or downward tendencies.

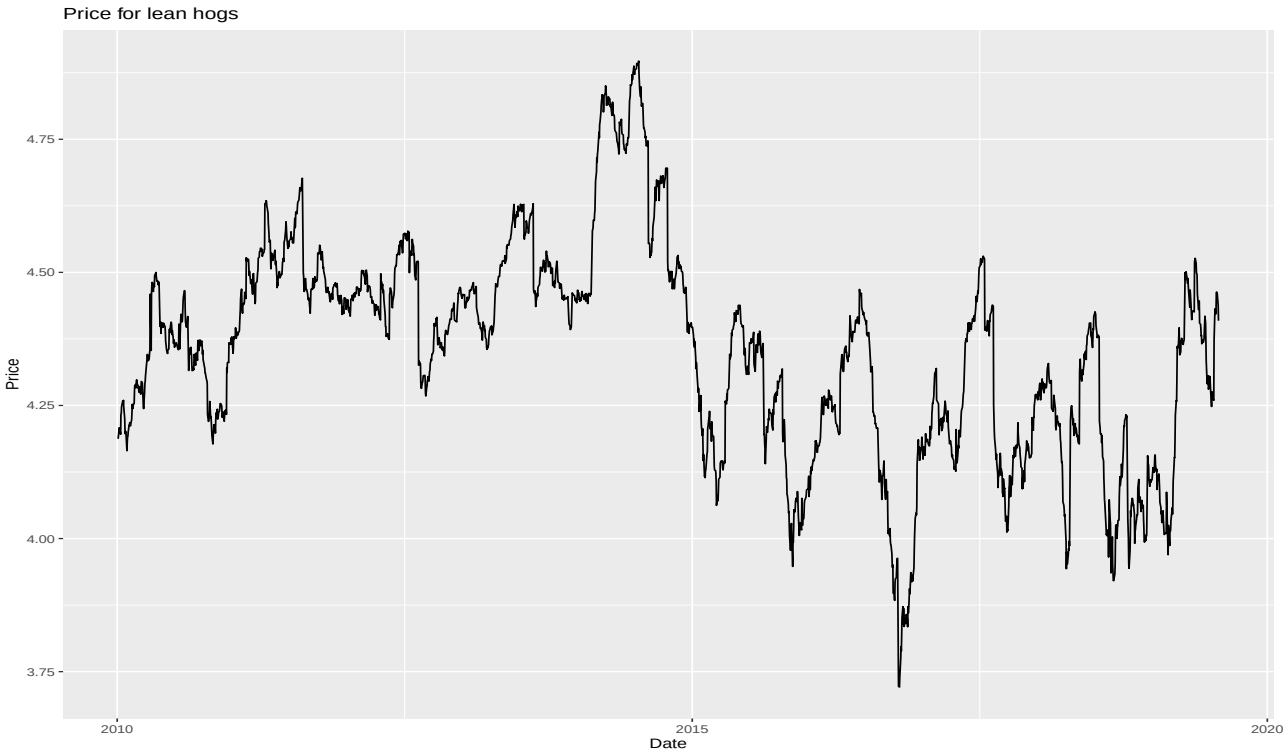

Figure 1: Natural logarithms of futures contracts prices for lean hogs.

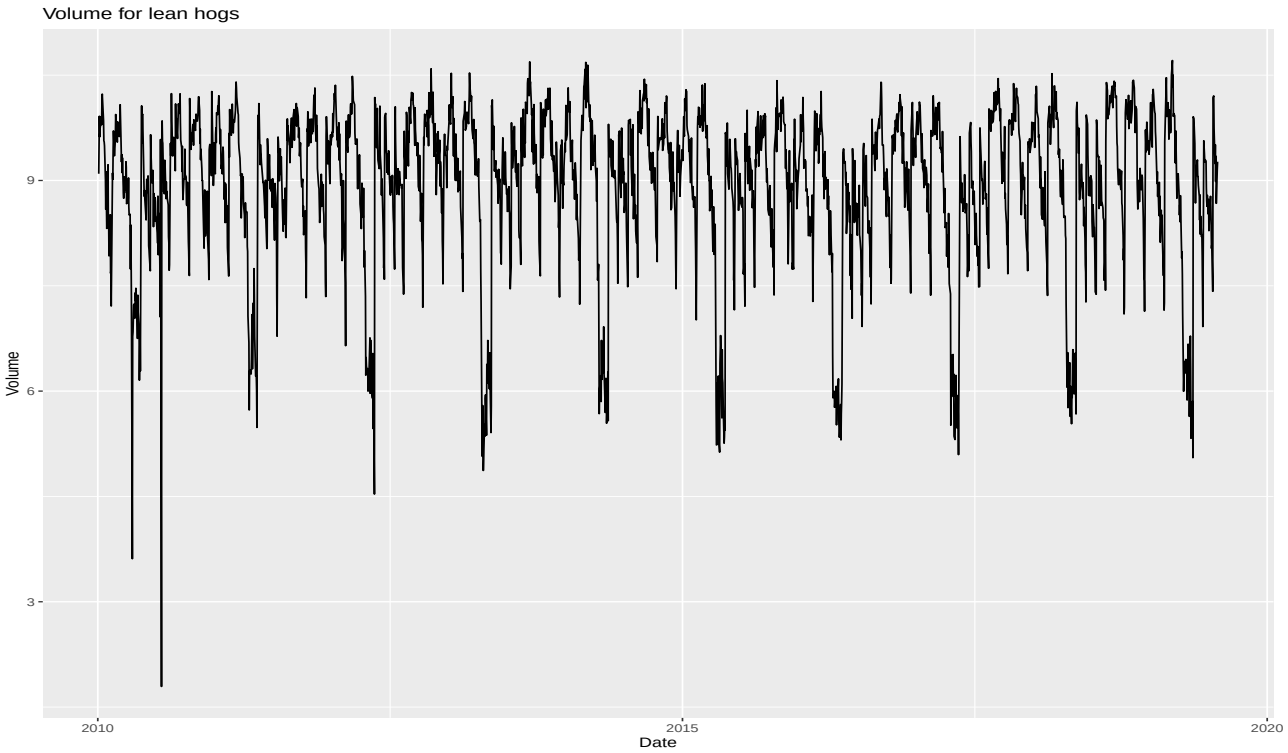

Figure 2: Natural logarithms of futures contracts trading volume for lean hogs.

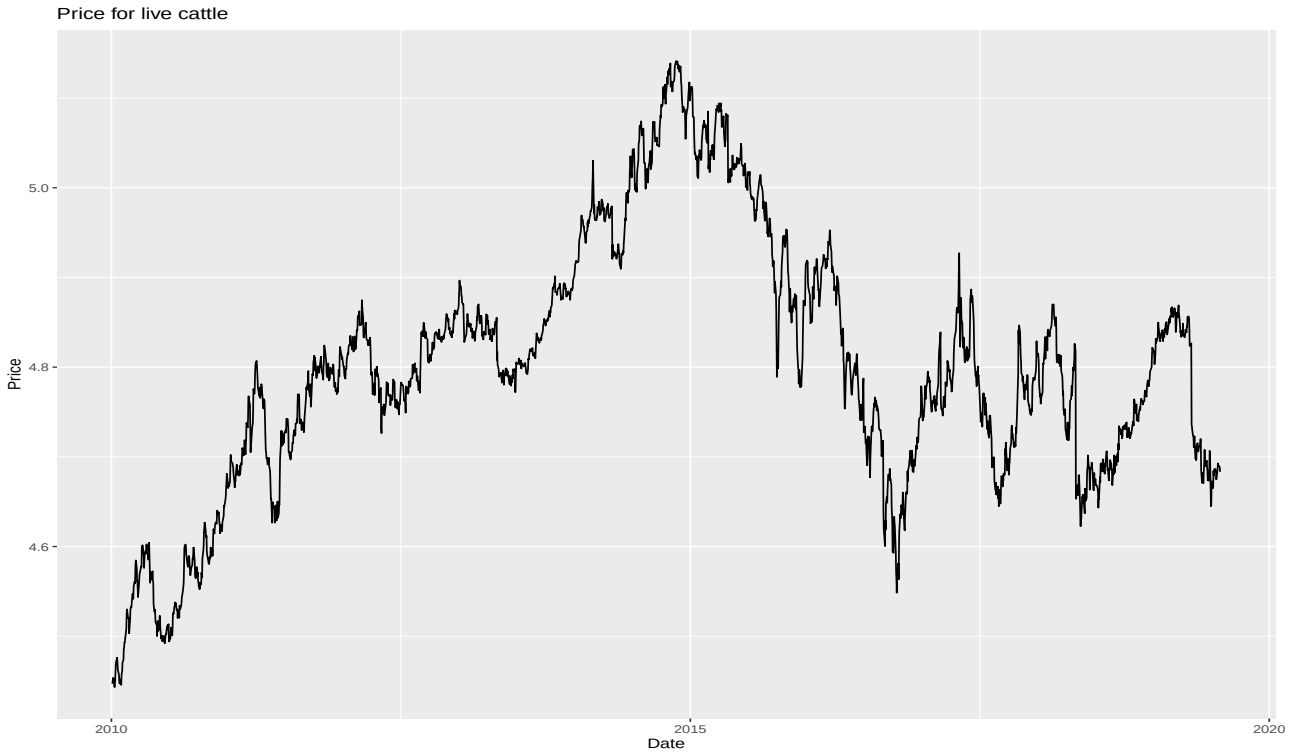

Figure 3: Natural logarithms of futures contracts prices for live cattle.

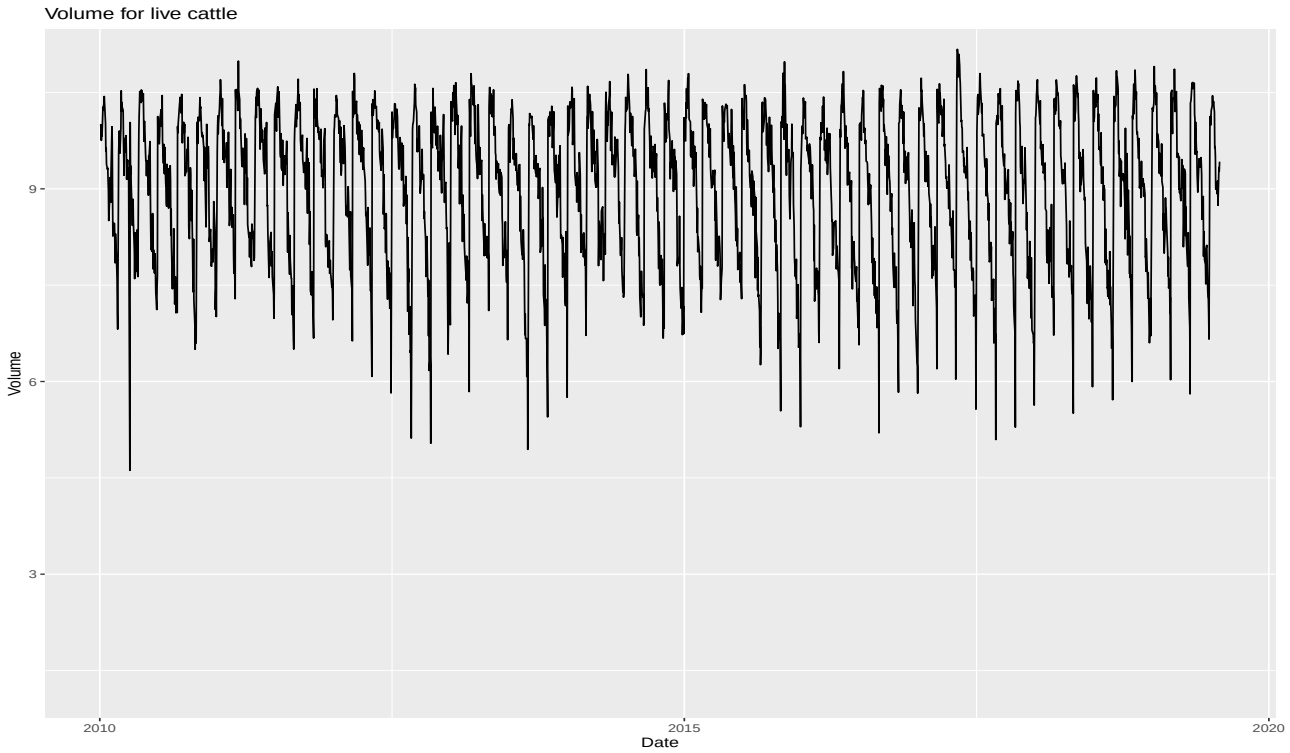

Figure 4: Natural logarithms of futures contracts trading volume for live cattle.

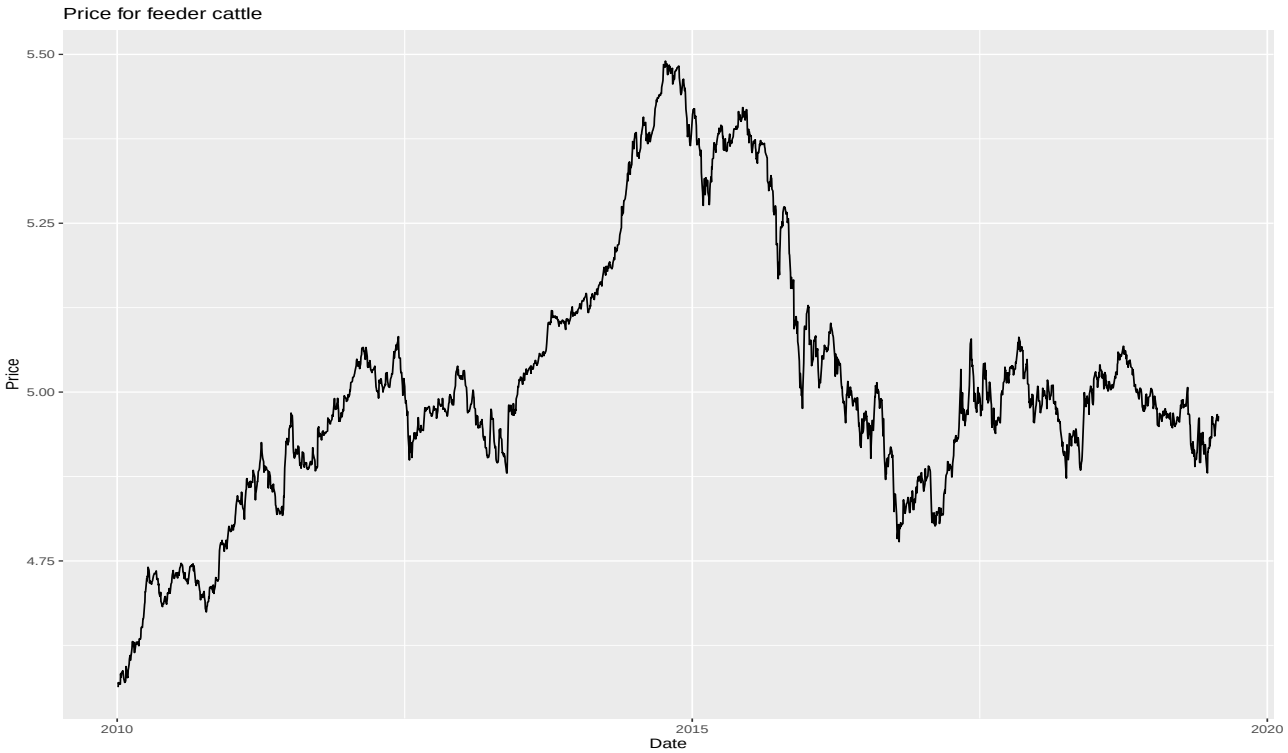

Figure 5: Natural logarithms of futures contracts prices for feeder cattle.

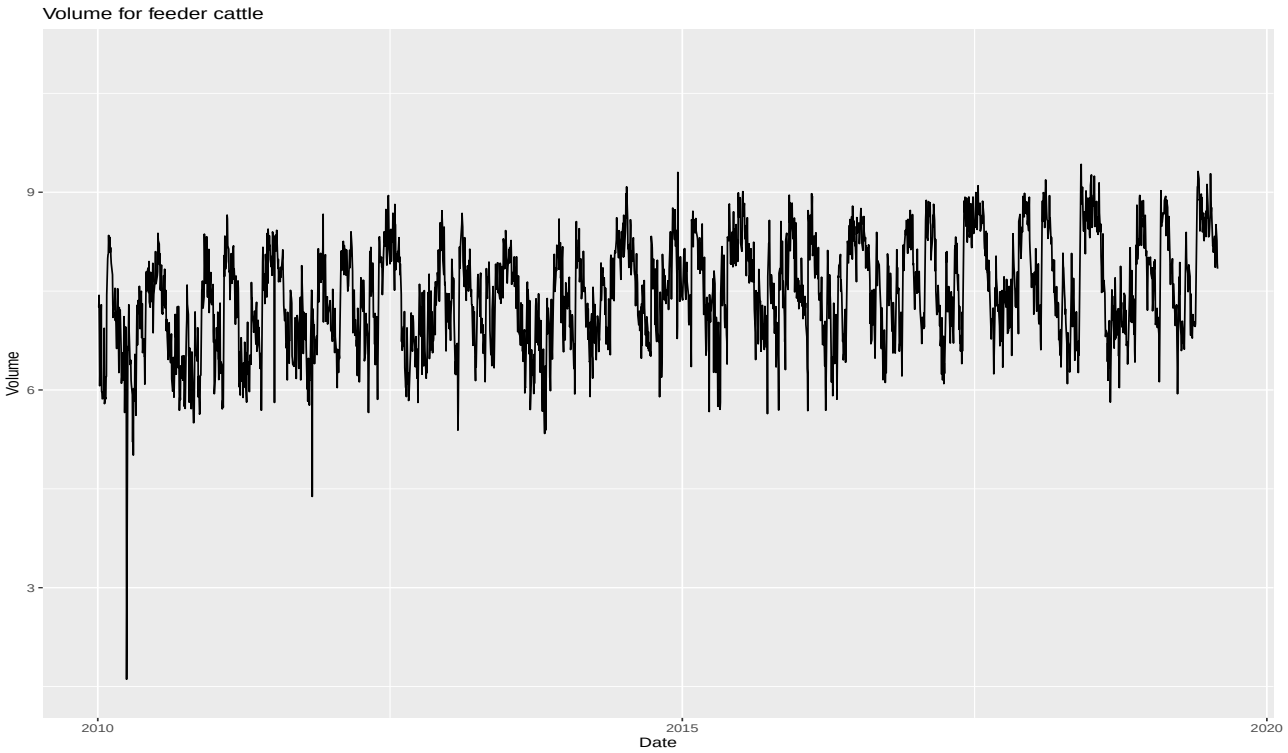

Figure 6: Natural logarithms of futures contracts trading volume for feeder cattle.

3.1 Stock Markets

DERIVATIVES

The derivative is an over-the-counter contract between two or more parties, and the derivative determines the price from fluctuations of the asset. The most common assets for derivatives are stocks, bonds, commodities, currencies, interest rates, and market indexes. Trading commodity futures is volatile and risky, it is rarely suitable for individual investors or retail customers. Many individuals lose all of their money, and can be required to pay more than they invested initially. When the price goes down, the investors will have profits.

• Futures Contracts

Futures contracts are commonly known as "spot" or "cash" contracts. Are standardized forward contracts that are transacted through an exchange. Those contracts reduces the risk of the variance cost in inputs. In futures contracts the buyer and the seller define product, quantity, location at a later date at an agreed price. When the price goes up the buyer has profit but when the price goes down the seller makes money.

Futures allow big profits, minimized-deposit accounts control full-size contracts where in other case it wouldn't be able to afford and investors can go long or short easily. But on the other hand futures can be very volatile and investment can be very risky, especially for inexperienced investors. Also the traders may lose the initial deposit before it is able to close the position and leverage increases both gains and losses.

In the 1840s, Chicago had become a commercial center and the 1848 evolved in a central place where farmers and dealers could meet to deal in "spot" grain - that is, to exchange cash for immediate delivery of wheat. The futures contract, evolved as sellers and buyers began to commit to future exchanges of grain for cash. Such contracts became common and were even used as collateral for bank loans. They also began to change hands before the delivery date. If the dealer (buyer) decided he didn't want the wheat, he would sell the contract to someone who did. Or, the farmer (seller) who didn't want to deliver his wheat might pass his obligation on to another farmer.

• Forward contracts

Usually forwards contracts are over-the-counter and don't trade on an exchange. Is an agreement between two parties to exchange at a fixed future date a specific quantity of a commodity for a specific price. The fixed price is called forward price. Such forward contracts began as a way of reducing pricing risk in food and agricultural product markets. These contracts are difficult to resell.

A forward market is an over-the-counter marketplace that sets the price of a financial instrument or asset and the quantity for specific future delivery. Forward markets are used for trading a range of instruments, like markets for securities, interest rates, commodities, but especially for the foreign exchange market. The flexibility of forwards attracts investors in the foreign exchange market. The differences between forward and futures contracts are that forward contracts can be customized to fit a customer's requirements, while futures contracts have standardized features. And forwards are executed between banks or between a bank and a customer, futures are done on an exchange trading market.

• Option contracts

An option gives the buyer the right to buy or sell a contract at a future specific date for a particular price and quantity. The seller is obliged to sell or buy the contract at the specific price and quantity at the future fixed date. There are two types of option contracts, put and call options. In call option you have the right to buy assets and in put option you have the right to sell the asset. There are four types in option. The long call where you buy the right to buy and the long put where you buy the right to sell. The short call where you sell the right to buy and the short put where you sell the right to sell. The put is preferable when price reduces.

There are two types of options, American and European. Owners of American-style options may exercise at any time before the option expires, while owners of European-style options may exercise only at expiration.

• Swaps

A swap is a derivative contract which two parties exchange the cash flows from two different financial instruments. The most common kind of swap is an interest rate swap. Most swaps involve cash flows such as a loan or bond. Usually, the principal does not change hands. One cash flow is generally fixed, while the other is variable and based on a benchmark interest rate, floating currency exchange rate or index price. Swaps do not trade on exchanges, and retail investors do not generally engage in swaps. Rather, swaps are over-the-counter contracts primarily between businesses or financial institutions.

3.2 Commodities

A commodity is defined as a product for which there is demand, but which is supplied without qualitative differentiation across a market. This means that a commodity remains constant no matter where it is sold, and there are no significant differences among products within a commodity group (called an asset class). The commodities have two categories, hard and soft. Hard commodities require mining or drilling to find, including metals like gold, copper, and aluminum and energy products like crude oil, natural gas and unleaded gasoline. Soft commodities refer to things that are grown, ranched or cannot be stored for long periods of time, including corn, sugar, cotton, cocoa, coffee, wheat, soybeans, and cattle.

Commodities are sold by producers (e.g. farmers, energy suppliers) and purchased by dealers (e.g. food processing companies). In order to protect them from sudden or significant swings in prices for a commodity, a financial mechanism was developed, the futures contract, which is a written agreement that specifies the size (quantity), price, grade (quality) and terms for delivering the good at a certain date in the future. These contracts are traded between producers, dealers or speculators.

Because of frequently changes in supply and demand, volatility in commodities tends to be higher than for stocks, bonds, and other types of assets. Some commodities show more stability than others, such as gold, which also serves a function as a reserve asset for central banks that provides a buffer against volatility. Yet even gold becomes volatile sometimes.

There are pros and cons in every commodity investment. The pros are that it is the most direct way to invest in commodities and there is a possibility for

strong returns. It perform well on a large scale. Also avoid the burden of physical ownership if you so choose. On the other hand some people find the vast quantities of a commodity that most futures contracts cover to be more exposure than they need, major institutions like the fact that they can obtain massive amounts of a desired commodity with relatively little effort. Also there is possibility for heavy losses and the minimum deposits necessary.

Commodity trading was an essential business. Ancient civilizations traded a wide array of commodities, from seashells to spices. Commodity-based money and commodity markets are believed to have originated in Sumer between 4500 BC and 4000 BC. In the late 10th century, these markets grew as a mechanism for allocating goods, labor, land and capital across Europe. The Amsterdam Stock Exchange, was the first stock exchange, originated as a market for the exchange of commodities. The US Bureau of Labor Statistics began the computation of a daily Commodity price index that became available to the public in 1940. By 1952, they issued a Spot Market Price Index that measured the price movements of 22 sensitive basic commodities whose markets are presumed to be among the first to be influenced by changes in economic conditions.

Commodities are traded in U.S. dollars. There is an inverse relationship between the dollar and commodities. As the value of the dollar increases, the price of commodities falls. That's because traders can get the same amount of commodities for less money.

The price of a commodity good is typically determined as a function of its market as a whole. Well-established physical commodities have actively traded spot and derivative markets. The sale and purchase of commodities are usually carried out through futures contracts on stock markets. Commodity markets can include physical trading and derivatives trading using spot prices, forwards, futures, and options on futures.

The first investable commodity futures index was the Goldman Sachs Commodity Index, created in 1991, known as the "GSCI". The next was the Dow Jones AIG Commodity Index. It differed from the GSCI primarily in the weights allocated to each commodity. The DJ AIG had mechanisms to periodically limit the weight of any one commodity and to remove commodities whose weights became too small. After AIG's financial problems in 2008 the Index rights were sold to UBS and it is now known as the DJUBS index. Other commodity indices include the Reuters / CRB index and the Rogers Index. Commodities exchanges include, Bourse Africa (formerly GBOT), Bursa Malaysia Derivatives (MDEX), Chicago Board of Trade (CBOT) which was the world's oldest futures and options exchange, Chicago Mercantile Exchange (CME), Dalian Commodity Exchange (DCE), Euronext.liffe (LIFFE), Kansas City Board of Trade (KCBT), London Metal Exchange (LME), Marché à Terme International de France (MATIF), Mercantile Exchange Nepal Limited (MEX), Multi Commodity Exchange (MCX), National Commodity and Derivatives Exchange (NCDEX), National Commodity Exchange Limited (NCEL), New York Mercantile Exchange (NYMEX).

During the late 20th century, exchanges opened and merged as the volume of traded contracts increased dramatically.

The Chicago Board of Trade (CBOT) originally traded corn, wheat, oats and

soybeans, but has grown to offer over 25 products. Its first financial product, a Guaranteed National Mortgage Association, was added in 1975. The exchange continued its broadening in 1982 by introducing a new category for trading called an option. The Board started an electronic trading system in 1994 to facilitate a more fluid transaction process, which still used today for some commodities. There are more than 3600 members of the CBOT who traded nearly 35 million in January 2009. The exchange merged with the Chicago Mercantile Exchange in 2007, becoming part of the CME Group. Up to today, there are already ten commodity exchanges established in the US, with the CBOT being the largest.

The Chicago Mercantile Exchange (CME) began as the Chicago Butter and Egg Board in 1898 and evolved into the Mercantile Exchange in 1919. Starting as an agricultural exchange, the CME added livestock in 1961 with the first frozen pork belly contract. It introduced the world's first financial products in 1972, dealing contracts on seven foreign currencies. In 2007, the CME merged with the CBOT to become the CME Group. The group expanded further as it acquired the New York Mercantile Exchange in 2008.Today it manages trade volume of around six million contracts on a daily basis.

The New York Mercantile Exchange (NYMEX) was founded in 1882, it is the world's largest physical futures exchange, includes the Commodity Exchange (COMEX), established in 1933 when a collection of smaller trading groups merged. NYMEX pioneered energy futures in 1978 and still is. It also include metals, coffee, cocoa, sugar and environmental products. The exchange traded an average of 1.3 million contracts per day in 2008.

The New York Board of Trade (NYBOT) (in 2007) dating back to 1870 when it began as the New York Cotton Exchange (NYCE). In 1882 the Coffee Exchange joined the NYCE and Sugar Exchange in 1916 after issuing its first sugar contracts. The Cocoa Exchange later merged with the CSE creating the Coffee, Sugar and Cocoa Exchange (CSCE). The NYCE and CSCE officially became the NYBOT in 2004. In October 2008, the exchange traded just under 8.2 million contracts for the month.

The Kansas City Board of Trade (KCBOT) was founded in 1856 as a clearinghouse for grain merchants. Today the primary use is as a grain exchange. It trades over 10,000 contracts per day on average, mostly wheat products.

The Minneapolis Grain Exchange (MGEX) began as the Minneapolis Chamber of Commerce in 1881 issuing its first futures contract on hard red spring wheat. It operated as the Chamber until 1947 when it became the MGEX which trades both the commodities contracts and agricultural index futures. Since 1997, the MGEX has averaged over one million contract trades per year.

The Intercontinental Exchange (ICE) began trading in 2000 using a technology infrastructure that linked markets together. In 2001, it acquired the International Petroleum Exchange (IPE), following that with a purchase of the NYBOT in 2007. The ICE has helped expand the market for over-the-counter (OTC) futures, which are typically too small to be listed on major exchanges. Over 219 million shares traded over the ICE networks in 2008.

• COMMODITY FUTURE MARKET

Commodity futures contracts offer direct exposure to changes in commodity

prices. Certain exchange-traded funds are custom-tailored to offer commodity exposure. The best investment in commodities are those where the logistics are easiest to handle, like gold.

But when it comes to large scale investing, futures contracts are the best way to purchase materials. These allow businesses and institutions either to pre-purchase or pre-sell a certain amount of a material for a future date to avoid the usually risky nature of the commodity market. While individual investors will not engage in this, companies can benefit hugely from doing so. The major exchanges of futures being located in Australia, Canada, England, France, Singapore, Japan and New Zealand.

Futures contracts are the oldest way of investing in commodities. The world's first commodities arose from agriculture practices (crop production and raising livestock). The trading of these materials traced back as the Sumerians in 4500 B.C. Agriculture developed around 10,000 BC, as humans began settlements and farming. An agricultural revolution started around 8,500 BC, which led to trading commodities between settlements. As trading developed, producers and dealers looked for ways to preserve the price of their products. Factors such as weather, conflict, and supply and demand wreaked havoc on pricing. In addition, as supplies became more plentiful, storage was necessary; merchants sought ways to raise money while their product sat until being sold. This is how futures agreements began.

According to Bruce Babcock, (Babcock, 2009), the first recorded commodity futures trades occurred in 17th century Japan, though there is some evidence that rice may have been traded as far back as 6,000 years ago in China. Future trading is a natural progression of things in response to the difficulties of maintaining a year round supply of products which are dependable on seasons like agricultural crops. In ancient Japan, rice used to be stored in warehouses for future consumption by the rice merchants. To raise funds, these merchants would then sell their rice tickets. Later, these rice tickets came to be regarded as a sort of all-purpose currency. As trading in rice tickets became more widespread, rules to standardize the trading of these rice tickets were introduced. In a way, these rules were akin to the current rules of the US Futures trading.

Futures trading began in the US only towards mid 1800s. The demand for standardized contracts for trading agricultural products led to the development of commodity futures exchanges. During the same period agricultural commodities – notably grains – were brought from Midwest farmlands to Chicago for storage until being shipped out to the east coast. Because agricultural products are perishable, the quality of the stored items would usually deteriorate over time. While stored, the purchase prices would occasionally change so the first contract for a future price was created. This forward contract allowed a buyer to pay for the commodity prior to taking delivery of it.

As more farmers and merchants began delivering their wares to Chicago, the first American exchange was set up in 1848. It was called the Chicago Board of Trade (CBOT). In the 1930s and 1940s some others food commodities were added to the Commodity Exchange Act and traded through CBOT, adding to the list of grains, products as rice, mill feeds, butter, eggs, Irish potatoes and soybeans. Futures are secured by physical assets. The sale and purchase of commodities are usually carried out through futures contracts on exchanges that standardize the

quantity and minimum quality of the commodity being traded. Business owners can use commodity futures contracts to fix the selling prices of their products weeks, months, or years in advance.

Commodity futures contract used as an agreement to buy or sell a particular amount of a commodity at a specific price on a specific date in the future. On futures contracts, the buyer has an obligation to act. Unless he unwinds the futures contract before expiration, then buyer and seller must either buy or sell the underlying asset at the stated price. The future commodities usually negotiate with agricultural products and spot contracts. In spot market buyer and seller agree now the price, the quantity and the transaction happens now. Commodity futures contracts are called by the name of their expiration month. Some commodities can have a significant amount of price volatility or price fluctuations. As a result, there's the potential for large gains but large losses as well. Moreover in commodities futures contracts the agreement will be fulfilled by actual delivery of the commodity. Some contracts allow cash settlement in lieu of delivery and usually the contracts are liquidated before the delivery date.

For over 100 years, agricultural products remained the primary class of futures trading. The CBOT added soybeans in 1936. In the 1940s, exchanges included trading for cotton and lard. Livestock was added to the trading "block" during the 1950s. Contracts for precious metals like silver started trading during the 1960s. Throughout the 80s and 90s, stock market index benchmarks like the SP 500 and government debt instruments were added to the list of tradable futures.

During the 20th century, exchanges opened up all over the United States. Cities such as Milwaukee, New York, St. Louis, Kansas City, Minneapolis, San Francisco, Memphis, New Orleans and others hosted trading, but Chicago remained the most influential location for commodities futures trading. Currently, the ten most active exchanges conduct over one billion trades per year, and there are exchanges in over 30 countries.

If the price of the commodity future contract increases, the buyer makes money. He gets the product at the lower price and then sells it at a higher price. By fixing the price of the commodity, buyers are purchasing. That reduces their risk that prices will go up. If the price decreases, the seller will make money. He can buy the commodity at a lower price today and sells it to the futures buyer as a higher price. Sellers of these commodities use futures to guarantee they will receive the agreed-upon price. They remove the risk of a price drop. That's because the prices of commodities change on a weekly or even daily basis. Contract prices change as well. That's why the cost of meat, gasoline, and gold changes so often. As the demand for goods and services increases, the price will go up, so the price of commodities will increase too and vice versa.

Disruptions in supply might lead to a stable and predictable demand. On the demand side, global economic and technological development may affect the prices. In case of inflation, commodity prices increase when inflation rises, which is why investors prefer them for their protection during times of inflation especially in unexpected inflation. Precious metals can also be used as a hedge against high inflation or periods of currency devaluation.

There are two types of investors that trade in the futures contracts. The most

participants are “hedgers” who trade futures to maximize the value of their assets. They want to reduce the risk and prevent losses from price movements rather than to speculate, so they lock prices of the commodities which they sell or used in production. When a company locks in the price and the price increases, then the company would have a profit. Hedgers want to protect their investments from the volatility of the price and they make or take delivery of the actual commodity when the futures contract expires. Moreover speculators and companies can trade both sides of the market and companies can hedge the price of necessary commodities, also they can control costs. As much larger and unpredictable is the price variability in a commodity, the greater is the price risk in it. Hedging a commodity can lead to a company missing out on favorable price moves since the contract is fixed regardless of where the commodity's price trades in the future. The high degree of leverage can increases losses and lead to margin calls and significant losses. Without future contracts and hedging the companies will bankruptcy because there would be no predictability.

The others type is "speculator" who attempt to profit from price changes in futures contracts. Many of the futures markets are very liquid and have a high degree of daily range and volatility, making them very tempting markets for intraday traders. Theses traders close out their positions before the contract is due and never intend to take actual delivery of the commodity when the futures contract expires. With the obligation to buy or sell the commodity, there's a risk. The trader might failure to close an existing position and as a result, investor will take delivery of a large quantity of unwanted commodities.

The safest investment in commodities futures are through commodity funds. They can be commodity exchange-traded funds or commodity mutual funds. These funds incorporate the commodities futures that occur at any given time. Trading in commodity futures and options contracts is very complicated and risky because commodities' prices are very volatile. Those funds, which trade like stocks, allow an easy way to investors to participate in commodity price fluctuations without investing directly in futures contracts and there are no fees. On the other hand not all commodities have funds that associated with them and a big move in the commodity may not be reflected by the funds.

• TRADED COMMODITY CLASSES

The commodities futures contracts has four categories which are metals, energy, livestock and meat and agricultural. Soft commodities are goods that are grown, such as wheat, or rice. Hard commodities are mined. There is little differentiation between a commodity coming from one producer and the same commodity from another producer.

• Energy

Energy futures are Oil (in various blends and grades) like WTI Crude Oil (WTI is the underlying commodity of Chicago Mercantile Exchange's oil futures contracts), Brent Crude, Heating Oil, Natural Gas, and RBOB Gasoline. The fossil fues includes Crude oil, Natural gas, Coal, Uranium/nuclear power, Electricity, Solar power, Wind power and Ethanol.

Energy Commodities are highly volatile so it is a very difficult market to safely invest in. Due to world dependence, price movements are difficult to predict as they

are influenced by market factors and political motives. Energy commodities consider mostly as hard commodities that are mined or extracted. Traders can invest through futures contracts, options, exchange-traded funds and stocks of companies. The price of these commodities is one of the most watched economic indicators given the correlation between economic growth and energy consumption. Energy prices affect the cost of everything we consume, so their price influences other commodities since it takes energy to produce them. The price of energy commodities can influenced by global economic up and downturns, by production cuts or increases and by emerging green energies. Their prices have the ability to rise dramatically over shorter time frames when demand goes up or supply drops. Investments in energy can hedge against rising prices. They used in industrial applications and they drive inflation, which makes them an effective hedge against it.

The unit to measure the heat content of fuels energy is the British thermal unit (Btu). According to the US Energy Information Agency (EIA), annual worldwide energy consumption is expected to grow up to 28% quadrillion Btu by 2040.

The energy has two types, the renewable, which is energy that can easily be replenished and accounts for about 21% of global electricity generation and about 12.5% of overall energy consumption. The main renewable energy sources are solar, geothermal, wind, biomass and hydro power. The other type is non-renewable, which is energy that can't be replenished. Almost 90% of the energy consumed worldwide derives from five non-renewable sources, which are petroleum products, hydrocarbon gas liquids, natural gas, coal and nuclear energy. The most developed commodity trading markets are in non-renewable energy resources.

The most productive countries in energy worldwide are Russia in crude oil with 10.500.000 barrels per day, United States in natural gas with 766 billion cubic per year, ethanol with 15.329 millions of gallons per year, heating oil with 18.119 thousand barrels per day and gasoline with 8.900 thousand barrels per day, China in coal with 3.874 million tones per year and electricity with 6.142 billion kWh per year.

The leading energy indices are S&P 500 Energy Index, Dow Jones U.S. Select Oil Equipment and Services Index, Dow Jones US Utilities Index, Dow Jones US Coal Index and Nasdaq Clean Edge Green Energy Index. Global economic developments and reduced oil production around the world can probably increase the oil prices and generally the prices. Economic downturns, production changes by the Organization of the Petroleum Exporting Countries (OPEC) and emerging technological advances that aim to supplant crude oil as an energy purveyor should also be considered.

• Metals

Metal Commodities describes all mined minerals, which are standardized on regulated exchanges. The most common metals futures are Gold (Spot), Silver, Platinum (Spot), Palladium and Copper. The types of metals are Gold, Silver, Platinum, Steel, Aluminum, Copper, Palladium, Lead, Nickel, Zinc and Tin. Iron was the latest addition to metal derivatives. Metals are grouped in two categories, the precious metals, which are rare, naturally occurring metallic elements like gold, silver, platinum and palladium. Precious metals are more commonly used as investment tools or to store value in form of jewelry and other decorative items.

A specific category in commodity trading of metals is concentrates, where this mined material is composed of multiple metal components such as copper, gold, zinc

but also waste material. Concentrates can be traded and are depending on assays where multiple parties measure the actual contents of the mined materials.

The other category is base metals, which are metals widely used in commercial and industrial applications. It comprises all metals which are mainly used for industrial purposes, as aluminum, copper, iron, lead, molybdenum, nickel, steel, tin, zinc.

The countries that producing the bigger percentage of metals are China in gold with 455 thousand metric tons, in aluminum with 31.000 thousand metric tons, in lead with 2.400 thousand metric tons, in molybdenum with 90.000 thousand metric tons, in steel with 685 thousand metric tons, in tin with 100.000 thousand metric tons, and in zinc with 4.500 thousand metric tons, Mexico in silver with 5.600 thousand metric tons, South Africa in platinum with 120.000 thousand metric tons, Russia in palladium with 82.000 thousand metric tons, Chile in copper with 5.500 thousand metric tons, Australia in iron with 852 thousand metric tons, in lithium with 14.300 thousand metric tons and Philippines in nickel with 500.000 thousand metric tons.

Many long-term trends could create investment opportunities in metals. These trends are Chinese demand, technological innovation, environmental regulations, population growth and BRICS countries (Brazil, Russia, India, China and South Africa).

Gold prices are highly volatile, driven by large flows of speculative money. Precious metals can used as a hedge against high inflation or periods of currency devaluation. The main exchanges for these precious metals are COMEX, NYMEX and LME. The greatest metal Indices are S&P GSCI Precious Metals Index, S&P GSCI Industrial Metals Select, DBIQ Optimum Yield Industrial Metals Index Excess Return and UBS Bloomberg CMCI Industrial Metals Index Total Return. Industrial metals are sold by the metric ton through the London Metal Exchange which trades include copper, aluminium, lead, tin, aluminium alloy, nickel, cobalt, molybdenum and New York Mercantile Exchange.

• Agriculture

Agricultural futures are Corn, Soybeans, Wheat, Rice, Cocoa, Coffee, Cotton, and Sugar. Agricultural divides into some types, which are Cocoa, Coffee, Cotton, Diary, Grains, Palm Oil, Rubber, Soybeans and Sugar. Most grain commodities have a strong price relationship with one another. These commodities refer to grains such as wheat, barley, corn (maize) and oilseeds such as soya and canola. In February 2013 included lumber (timber and forests), soybeans, oilseeds, livestock (live cattle and hogs), dairy products. These commodities can also include grains excluding stored grain (wheat, oats, barley, rye, grain sorghum, cotton, flax, forage, tame hay, native grass), vegetables (potatoes, tomatoes, sweet corn, dry beans, dry peas, freezing and canning peas), fruit (citrus such as oranges, apples, grapes) corn, tobacco, rice, peanuts, sugar beets, sugar cane, sunflowers, raisins, nursery crops, nuts, soybean complex, aquacultural fish farm species such as finfish, mollusk, crustacean, aquatic invertebrate, amphibian, reptile, or plant life cultivated in aquatic plant farms. Soft commodities refer to cocoa, coffee, sugar and cotton. Also refer to food and fiber as well as livestock and meat. Meat commodities include live animals raised for meat, hide, organs, bones and hooves and cuts of meat produced during the butchering

of animals. The categories are Feeder Cattle, Live Cattle, Lean Hogs and Pork Bellies. Soft commodities refer to commodities that are farmed rather than mined. Those commodities are Cocoa, Coffee, Frozen Concentrated Orange Juice (FCOJ) and Sugar.

In the U.S. today are two types of farming, the commodity agriculture is based on the primary objectives of farming should be to produce as much food/fiber as possible for the least cost. It is driven by productivity and efficiency. On the other hand civic agriculture, represents the rebirth of a more locally oriented agriculture and food system.

Agricultural Commodities describe the editable commodities and farming products. These commodities have some disadvantages in their characteristics in comparison to the other commodities, such as limited preservability and highly depended on weather conditions. The common uses of agricultural are for food source for animals, food source for people, feedstock for fuel production, food and industrial oil or lubricant and for industrial uses.

The market of grains and agricultural products can be extremely volatile during summer months or periods of weather transitions. The price in agricultural products can increase due to population growth combined with limited agricultural supply. With futures and hedging in agriculture, volatility in commodities avoid bankruptcies for businesses. It is an enormous industry with over 1.3 billion people – nearly 20 percent of the global population – working in farming. South Asia and Sub-Saharan Africa are the countries with more employees that any other industry. According to the Food and Agricultural Organization of the United Nations, the economic value of the agriculture industry, in constant 2010 dollars, is more than $ 3 trillion. In the U.S, in 2017, only about 4% of farms have sales over $1m, but these farms yield two-thirds of total output.

In 1992-2000 agriculture considered as the most dangerous industry, accounting for 42% of all fatalities of young workers, mostly under age of 15. With the risk of fatal injury is four times the risk for young workers in other workplaces. In 2004, 24% of farmers were women. In 2009 a huge number of people under age 20 worked on farms owned by their family. In 2012, the median pay was $9.12 per hour or $18,970 per year.

From 1999–2009, roughly 50% of hired crop farmworkers in the U.S. were noncitizens working without legal authorization, mostly were Chinese, Japanese, Indian, Pakistani, and Mexican. These workers earn an average of 15% less than one workers with amnesty or green card.

Agricultural commodities fall into one of six categories: Cereal Grains, Oilseeds, Meat, Dairy, Other Soft Commodities and Miscellaneous Agricultural Commodities. The main exchange is CBOT (Chicago Board of Trade), NYMEX(New York Mercantile Exchange), ICE (Intercontinental Exchange), CME (Chicago Mercantile Exchange), N/A(for Pork Bellies), ASX(Australian Stock Exchange), TOCOM(Tokyo Commodity Exchange) and SHFE(Shanghai Futures Exchange). Several long-term trends as population growth, technology, big data and finally global warming could affect the investment in agriculture.

According to commodity.com for agriculture and livestock commodities, the countries that affect and produce more are European Union in barley with 58.765

thousand metric tons, in oats with 8.002 thousand metric tons, Ivory Coast in cocoa with 1.449 thousand metric tons, Brazil in coffee with 2.595 thousand metric tons, in orange juice with 1.257 thousand metric tons, in sugar with 39.150 thousand metric tons, United States in corn with 377.500 thousand metric tons, in feeder cattle with 12.448 thousand metric tons, in live cattle with 12.448 thousand metric tons, in lumber with 357 million m3, in soybeans with 17.024 thousand metric tons, India in cotton with 30.000 lb. Bales, China in lean hogs with 54.750 thousand metric tons, in pork bellies with 52.750 thousand metric tons, in rough rice with 146.000 thousand metric tons, in wheat with 126.000 thousand metric tons, Indonesia in palm oil with 36.000 thousand metric tons, Thailand in rubber with 4.305 thousand metric tons and Australia in wool with 478 thousand metric tons.

The five leading agriculture Indices are S&P GSCI Agriculture Index, Dow Jones – UBS Grains Sub Index Total Return, iPath Bloomberg Agriculture Total Return, iPath Bloomberg Livestock Total and E-TRACS USB Bloomberg Commodity.

• Livestock and Meat

Livestock refers to any breed or population of animal kept by humans for a useful and commercial purpose. The main Livestock and Meat futures commodities are Lean Hogs, Pork Bellies, Live Cattle, and Feeder Cattle. The livestock complex consists of Lean Hogs, Feeder cattle, and Live Cattle.

The top States in Livestock and Poultry slaughtering are for cattle at Nebraska, Kansas, Texas, Colorado, California, Wisconsin, Washington and Pennsylvania. For hog are at Iowa, Minnesota, Illinois, Indiana, Missouri, Oklahoma and Pennsylvania. For chicken are at Georgia, Arkansas and Alabama. And for turkey are at Minnesota, North Carolina and Arkansas. But only four companies produce 85 percent of the beef in the United States in 2013 which were Tyson, Foods, JBS, Cargill and Smithfield Foods.

According to a 2016 analysis the U.S. industry accounts for $1.02 trillion in total economic output or 5.6 percent of gross domestic product (GDP). In 2017, export value of beef and beef variety meat exports reached a record $7.27 billion. On a volume and value basis, the top four markets for U.S. beef were Japan, South Korea, Mexico and Hong Kong. At the same year the U.S. exported 2.45 million metric tons of pork and pork variety meat, up 6 percent of the last year. Annual total pork shipments were valued at $6.49 billion, up 9% from 2016. The top markets for U.S. pork in terms of volume and value at that period were Mexico, Japan and South Korea. Furthermore the U.S. exported 3.7 million MT of poultry and poultry variety meats in 2017. The value was estimated at $4.5 billion. Exports accounted for 26.6 percent of U.S. pork production and 12.9 percent of beef production.

Livestock production, meat processing and procurement affected of the number of available live animals, changing consumer demand weather patterns, disease, the cost of animal feed and changing consumer diets. All these factors may have impact in price movement. The fundamentals that impact the livestock market include production, supply and demand, livestock cycle and seasonality

Livestock futures began trading at CME Group in 1964, with the listing of Live Cattle futures. The livestock complex now includes futures and options on Live Cattle, Feeder Cattle and Lean Hogs. The term cattle refers to domesticated bovines, while livestock has a wider sense, with reference to any breed or population

of animal kept by humans for a useful, commercial purpose.

Livestock provide a variety of food and nonfood products and is commonly defined as domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, wool, pharmaceuticals, bone products, industrial protein, and fats. Very little animal biomass may be wasted at slaughter. Also the intestinal contents can be use as fertilizer. The term is sometimes used to refer at animals that are bred for consumption, while other times it refers only to farmed ruminants, such as cattle and goats. Red meats include pork, veal, beef and lamb. Horses are considered livestock in the United States. Livestock provide safety against the risk and is an economic buffer in some economies which may have problems with droughts, markets and other factors. It considered also as a diversification strategy. The value of global livestock production in 2013 has been estimated at about 883 billion dollars.

In these days, over 99% of livestock are raised on factory farms, because farmers can increased yield of the various commercial products, but these practises have negative impacts on animals and on environment.

Seasonality trends in livestock supply and demand are affected by calving and farrowing, when newborn cattle and hogs enter the herds that change throughout the year. Hog and cattle prices show regular trends where seasonal low prices are established during the months when animals are typically brought to market and seasonal high prices occur during feeding months, when the supply of market-ready animals is at its lowest.

The meat prices increased because of the high global demand for commodities and the meat prices tend to go up in the winter time, because transportation is more difficult due to weather conditions, and also producers tend to hold on to their livestock post harvest to fatten them up on cheap grain.

With hedging in futures, livestock buyers and sellers are essentially reducing their price risk by assuming basis risk. Hedging observed when the investors need protection against declining prices, such as hog farmers, cow/calf producers, feedlot operators and exporters and those who looking for protection against rising prices, like feedlot operators purchasing young feeder cattle, meat packers and importers. Generally if someone wants to sell livestock in the cash market, an appropriate hedge is selling futures and if he want to buy livestock in the cash market, an appropriate hedge is buying futures. It also observed the phenomenon of speculate, where speculators attracted to the market by the opportunity to realize a profit if the estimations are correct. In doing so, they provide market liquidity, which is the ability to enter and exit the market quickly, easily and efficiently.

Also, the price of a commodity for future delivery is higher than the cash price due to carrying costs (insurance, interest, and warehousing fees). This is called contango and the opposite is backwardation, when the price of a commodity for future delivery is lower than the cash price.

The most important factors of the main commodity futures prices are feed prices, weather, income growth, substitutes, hog cycle, diseases, energy prices, US dollar, seasonal trends and consumer preferences.

The changes in price have affect in quantity. When the price goes up a farmer may bring more animals in the market in order to have a bigger profit. A change in

the price of animal feed, may influence supply. Especially when the price for corn and soybeans goes up, producers may reduce the amount of time that animals are on feed to alleviate some of the impact of higher grain prices. Changes in population size, distribution and income, will impact the demand for protein from meat. The price of substitute or complementary products will also influence the demand for meat. Moreover, constantly changing consumer preferences, which can be inspired by many factors as age, advertising, will also impact the demand for livestock. Also government programs and interest rates, can also impact production decisions and supply.

Also the environmental impacts of factory farming include deforestation, unsustainable pressure on land (high-protein/high-energy animal feed), pesticide, herbicide and fertilizer manufacture (used for feed-crops and from manure) which cause pollution of soil, water and air, unsustainable use of water for feed-crops, groundwater extraction, land degradation, loss of biodiversity, worldwide reduction of genetic diversity of livestock and loss of traditional breeds and species extinctions.

• CATTLE

There are 8 breed of beef in the market the Angus, Beefmaster, Brahman, Brangus, Charolais, Santa Gertrudis, Senepol and Simmental.

Cattle are raised as livestock for meat, dairy products (milk), leather and as draught animals. Their hides, used for leather to make shoes, couches and clothing, are another widespread product. Mutton and chevon are eaten by more people than any other meat and beef is eaten in larger quantities than any other meat. As of 2009–2010 it is estimated that there are 1.3–1.4 billion head of cattle in the world. Depending on the breed, cattle can survive on hill grazing, heaths, marshes, moors and semi desert.

The beef industry is a global industry with an enormous economic impact. It considers as the basis of a multi billion-dollar industry worldwide. The international trade in beef for 2000 was over $30 billion and represented only 23% of world beef production. As an economic size the beef production is comparable with other productions such as milk, which is also made into cheese, butter, and yogurt. Beef production creates millions of jobs including suppliers, distributors and retailers. United States are the top cattle-producing nation in the world. World's biggest beef producing regions are United States of America (with 12.448 production per year), Brazil (with 9.700 production per year), European Union(with 7.900 production per year), China(with 7.110 production per year), India(with 4.300 production per year), Argentina (with 2.900 production per year), Mexico(with 1.960 production per year), Pakistan (with 1.800 production per year), Turkey (with 1.600 production per year) and Russia (with 1.300 production per year). (1.000 metric tons)

In 2010, the U.S. has 766,350 participants in beef raising, which is the biggest part in beef industry. Beef calves are generally raised in small herds, with over 90% of the herds having less than 100 head of cattle. Fewer producers participate in the finishing phase which often occurs in a feedlot, but there are 82,170 feedlots in the United States.

The United States has the 4th largest cattle inventory in the world in 2018 after India, Brazil and China and it is the world's largest beef producer. USA has high value exports with Australia, so the US market can have a significant impact on

Australian cattle prices, with 96.6 million head in 2007 to 88.5 million head in 2014. In the begging of 2019, the herd was up to 94.8 million head. Nonetheless the United States has less than 10% of the world's cattle inventory, it produces nearly 25% of the world's beef supply and more than 1 million beef businesses, farms, and ranches operate in 50 States. The producers in U.S. have focused on cattle uniformity and high-quality beef cattle too. Also the bull selection is the foundation for a profitable beef herd.

Inventory statistics from the USDA in 2018 showed that there are currently 94.4 million cattle and calves in the United States of America, which is 1% more animals than statistics from the same date in 2017 up from 93.7. Of these, there are 9.4 million dairy cows, and 31.7 million beef cows. Each year, about 39 million cattle and calves are killed for food in the U.S. Roughly 32.5 million cattle/year, were killed for meat to feed United States. So, approximately 89,041 cows/Day need to be killed to full-fill the cow meat lovers. Approximately 25 million farm animals are slaughtered each day in the United States. Also in the United States, approximately 9 billion chickens are killed for their flesh each year for human consumption, and 305 million hens are used for their eggs. The majority of these animals spend their lives in total confinement. In 2007, a typical broiler chicken at eight weeks old was 4.8 times as heavy as a bird of similar age in 1957.

In 2017, the meat and poultry industry processed: 9 billion chickens, 32.2 million cattle and calves, 241.7 million turkeys, 2.2 million sheep and lambs and 121 million hogs. The same year, American meat companies produced: 26.3 billion pounds of beef, 25.6 billion pounds of pork, 5.9 billion pounds of turkey, 80.2 million pounds of veal, 150.2 million pounds lamb and mutton and 42.2 billion pounds of chicken.

Livestock traders distinguish between two types of cattle – feeder cattle and live cattle. The difference between these two commodities is the stage of the production cycle.

The factors that move live cattle prices include Beef Demand, Cattle Feeding Spreads, Cattle on Feed Report and Feed Prices. Weather and disease, can lead to an increase or decrease of supply and demand for livestock. Live Cattle and Feeder Cattle futures and options serve commodity producers and users seeking risk management and hedging tools. Live Cattle are physically delivered contracts, while Feeder Cattle are cash-settled contracts.

• FEEDER CATTLE

The CME Feeder Cattle Index broadly represents the price of cattle purchased by feedlots that will likely grade select or higher, be placed on feed for an extended period, and finally marketed to a packer for slaughter. The Index underlies the CME Feeder Cattle futures contract. The states which included in the Index are Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas and Wyoming. Feeder Cattle futures trade in units of 50,000 pounds and in minimum price increments, or ticks of $12.50. They are listed for trading in January, March, April, May, August, September, October and November. At expiration, rather than calling for the delivery of physical cattle, Feeder Cattle futures are settled in cash at a price equal to the CME Feeder Cattle Index on the last day of trading. The Index is a seven-day weighted average and is defined as the total dollars sold during those days period divided by the total

pounds of feeder steers sold during the same period. The weight and frame score categories are, 700 to 899-pound Medium and Large Frame #1 feeder steers and 700 to 899-pound Medium and Large Frame #1-2 feeder steers.

If cash market prices go up, futures price are expected to go up as well. Hedge effectiveness is represented statistically by regressing cash prices on futures prices and measures the percent reduction in the variability of daily price changes between an unhedged versus hedged position.

Feeder cattle are weaned calves being fattened prior to slaughter and they weigh between 600-800 pounds. A newborn weighted 70 to 90 pounds typically in the Spring. Then it is weaned and allowed to graze for up to nine months in order to reach the minimum weight, at which point it is sent to a feedlot. At this point their diet is an aggressive feeding process that includes a high-energy feed as corn and other grains so cattle can gain weight. For that reason corn prices have a big impact on feeder cattle prices.

• LIVE CATTLE

Cattle raised for beef is the single largest part of American agriculture. The seven major cattle producing states are Arizona, California, Colorado, Iowa, Kansas, Nebraska, and Texas.

Live cattle are full-grown cattle that have reached the necessary weight for slaughter and are finished products that are ready for sale to slaughterhouses. Cattle typically get slaughtered when they reach a weight of between 1,200 and 1,400 pounds, but this can vary. Major traders of this commodity include meat manufacturers, grocery chains, and certain restaurant chains. Physical buyers of live cattle usually are meat packers who sell the meat and by-products.

Production of live cattle begins with breeding cows and bulls either naturally or with artificial insemination. Cows bred in the summer will produce calves in the spring. ne natural breed bull corresponds for 20 to 25 cows. Many producers prefer A.I. because they can better control the genetics of the calves. Each year ranchers typically cull about 15% to 25% of the cows in their herd and send them to slaughter. The most common reasons for culling a cow include the failure to reproduce, advanced age, bad teeth, drought conditions and high feed costs. Once the calves are born, a certain number of females are held back to replace the cows that are slaughtered. The remaining calves are raised for eventual slaughter.

The Chicago Mercantile Exchange (CME) offers a futures contract that settles into 40,000 pounds (18 metric tons) of live cattle and in minimum price increments of $10.00. They are listed for trading in the even months of February, April, June, August, October and December. Live Cattle is a physically-delivered futures contract, meaning that live steers are ultimately delivered.

One another category is Dairy Cow, where these commodities include milk, butter, whey and cheese. Markets for these commodities date back to the 19th century when traders organized the Chicago Butter and Egg Board.

A dairy cow is raised for the production of milk. There are 6 diary breed and each one offers unique characteristics. The Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey and Milking Shorthorn. Holsteins are the cows that produces the most milk. California is the leader of milk of any U.S. state, producing approximately 40 billion pounds of milk in 2018. Wisconsin was the second, producing about 30 billion

pounds of milk in that year. There are personal preference for choosing the breed of cattle but the main factors include characteristics like how much milk a cow will provide, the amount of fat and protein on average in the cow's milk, and the temperament of the breed.

In USA there are over three times more beef cows than milk cows. Inventory statistics from the USDA showed that the volume of milk where produced in the United States has been steadily increasing over the last several years. In 2007, the average milk yield of a dairy cow nearly doubled since 30 years ago. In 2018, total milk production in the U.S. was about 217.5 billion pounds, up from 192.9 billion pounds in 2010.

There are some advantages in that market of USA. The average milk production is 9,682 kg per cow per year which is higher than other countries. Also the U.S. dairy cattle perform in all climates and that industry is the most experienced and advanced in the world when measuring and tracking animal performance. U.S. milk production per cow has tripled in the past half-century as a result of improved genetics and management; genetics accounted for 55% of the improvement since the 1980s. Other leaders in the same industry follow the lineage to U.S. genetics up to 80-90%.

• HOG

Grower pigs are housed indoors in group-housing or straw-lined sheds, whilst pregnant sows are confined in gestation crates and give birth in farrowing crates. The use of those gestation crates has resulted in lower production costs, however, this practice has led to concerns about animal treatment. Pigs are omnivorous and they are generally fed by a combination of grains and protein sources (soybeans, or meat and bone meal). Alternatively, piggeries are reliant on the grains industry.

Piglets often receive range of treatments including castration, tail docking to reduce tail biting, teeth clipped and their ears notched to assist identification. In the USA, the federal Humane Slaughter Act requires pigs to be stunned before slaughter. It observed reducing in pig farms in USA, only 2002 there were 114.000 while in 1967 there were 1 million farms.

Lean Hog futures and options trade 24 hours a day on the CME Globex electronic trading platform. In addition, these contracts also trade on the trading floor during regular trading hours. Lean Hog futures and options are cash-settled contracts. The benefits of this market are management of price risk and engagement in price discovery, access to electronic markets and arbitrage and spread opportunities with other commodities, such as grains.

• LEAN HOGS

Lean Hogs in United States are produced mostly in Iowa, Minnesota, North Carolina and Illinois. Hogs are generally ready for market when they reach a weight near 250 pounds. Normally, it takes six months to reach out in that situation.

A market hog will typically yield 88.6 pounds of lean meat. This lean meat consists of an average of 21 percent ham, 20.3 percent loin, 13.9 percent belly, 3 percent spareribs, 7.3 percent Boston butt roast and blade steaks, and 10.3 percent picnic. The rest goes into jowl, lean trim, fat and miscellaneous cuts and trimmings.

Lean Hog futures allow investors, such hog producers and packers, to reduce the risk of price movements. Lean Hog futures trade in units of 40,000 pounds of hog

carcasses and in minimum price increments of $10.00. They are listed in February, April, May, June, July, August, October and December. As with Feeder Cattle, Lean Hog futures are settled in cash at expiration, to at a price equal to the CME Lean Hog Index on the last day of trading.

3.3 History of Animal Agriculture in the United States

Livestock production is a phenomenon that has been plagued by obscenity until today, and even with a strong upward trend. The summarization of the evolution of the market can be divide it into three long periods.

The domestication of those animals began back in 6,000 BC in China and in 8,500 BC in the Near East with pigs. Followed by chickens and other poultry may have been domesticated around 7000 BC. Then were cattle which have been domesticated since 10,500 years ago. About 10,000 years ago, ancient people domesticated cows which was 1.5 to two times as big as domestic cattle. In the beginning, cattle were used for meat, milk and labor but eventually were replaced by horses in most of the draft work. In 1493, Columbus brought livestock to the West Indies, cattle and sheep was brought to Mexico in 1519 by Cortez. In 1539, DeSoto brought horses and hogs to Florida. Livestock as a word was first used between 1650 and 1660. The American livestock began at Jamestown in 1607. William Pynchon, at Massachusetts, was first meat packer exporting salt pork, in 1641. In 1760, Robert Bakewell, in England, began breeding animals with purpose to create different types. In 1820 to 1975 automation became the reason were the number of people involved in farming dropped.

In 1861-1865, during the Civil War some changes took place as refrigeration in box cars allowed shipping of carcasses to population centers. Until the introduction of the refrigerated rail car in the 1860s, Western cattle farmers had a difficult transportation into East Coast markets. The number of cattle on Western ranches was doubled between 1880 and 1900. Before the war, pork considered as the most popular meat mainly because it was easy of storage, but beef became the most popular meat after the war because of refrigeration. After Civil War, in late of 18th century, livestock industry change because of the technological progress which was included barbed wire, gas tractor, silage and improved veterinary medicine.

During the Great Depression, in 1919, the government initiating tariffs and opening public lands for grazing and the producers began to experiment with cross breeding. In 1930, consequences of government intervention was showed and in 1940, the U.S. Department of Agriculture approved the use of nitrates. In 1939-1945, World War II, brought economic recovery but also price freezes. In post war boom years, refrigerated truck and feedlots grew was included. Some years later in 1966, factory farming of beef, dairy cattle and domestic pigs began. US beef consumption steadily rose until the 1970s but then the unstable economy and bad weather forced the price of grain to rise. In addition in 1973-1979, a combination of oil crisis, economics fluctuations and bad weather forced once more the price of grain to raise.

Unfortunately modern cattle industrial agriculture system may caused many impacts on human health through the diseases in animals. In the late twentieth century and in particular in 1987 mad cow disease and foot-and-mouth disease

appeared.

3.4 Descriptive statistics

Tables 1-3 present descriptive statistics and tests on the distribution for the rates of change of price and volume. They are calculated as $dlnP = lnPt_t - lnP_{t-1}$ where dlnP=rates of returns of price, $P = price$ and $dlnQ = lnQ_t - lnQ_{t-1}$ where dlnQ = rates of change in trading volume and $Q = volume$.

The skewness, in cases of the price returns for lean hogs and live cattle is negative and statistically significant, indicating a few negative changes. In the occasion of feeder cattle, it is positive and statistically significant. The volume returns skewness and in three cases is positive and statistically significant, because of p-value$<$0.01.

The price returns and volume returns for the kurtosis indicate positive and statistically significant relationship, pointing to leptokurtic distribution.

For the normality, the null hypothesis is strongly rejected in the three occasions.

Table 1: Lean hogs: Descriptive statistics for $dlnP$ and $dlnQ$

Statistics	dlnP	dlnQ
Min	-0.240643	-7.793793
Max	0.234774	7.603566
Mean	0.000064	0.000100
Median	0.000570	-0.058077
Stddev	0.022927	0.623610
Skewness	-1.31383	2.424621
Kurtosis	30.78552	36.47736
Tests	p-values	p-values
Skewness	< 0.01	< 0.01
Kurtosis	< 0.01	< 0.01
Normality	< 0.01	< 0.01

Table 2: Live cattle: Descriptive statistics for $dlnP$ and $dlnQ$

Statistics	dlnP	dlnQ
Min	-0.157422	-4.706761
Max	0.066349	5.420885
Mean	9.778615e-05	-0.000187
Median	0.000584	-0.053057
Stddev	0.011530	0.736538
Skewness	-2.202253	3.463092
Kurtosis	25.79111	23.11947
Tests	p-values	p-values
Skewness	< 0.01	< 0.01
Kurtosis	< 0.01	< 0.01
Normality	< 0.01	< 0.01

Table 3: Feeder cattle: Descriptive statistics for $dlnP$ and $dlnQ$

Statistics	dlnP	dlnQ
Min	-0.076245	-5.025195
Max	0.100047	5.051137
Mean	0.000163	0.000301
Median	0.000337	-0.032521
Stddev	0.010480	0.532543
Skewness	0.126697	0.954629
Kurtosis	12.84003	13.35292
Tests	p-values	p-values
Skewness	< 0.01	0.012
Kurtosis	< 0.01	< 0.01
Normality	< 0.01	< 0.01

Stylized facts of Returns

Stylized facts are a set of common features of financial data.

Fat tails: The unconditional distribution of returns has thicker tails than normal distribution, so using the normal distribution we will devalue the number and size of crashes and booms.

Asymmetry: The unconditional distribution is negative skewed showing that extreme negative returns are more often. The asymmetry and fat-tail facts insist on and after the arrangement of heteroskedasticity, which means that the conditional distribution is non-normal.

Aggregated normality: The return distribution approach to normal distribution.

Absence of serial correlation: Returns do not show a significant serial correlation unless they are at high frequency.

Volatility clustering: The serial correlation of volatility returns shows that a large return followed by another large return. The ultimate returns are the most strongly serially correlated.

Time-varying cross-correlation: The correlation of returns increases in periods of high-volatility.

4 Methodology

The quantile regression which was introduced by Koenker and Bassett Jr (1978), fits specified percentiles of the response, such as the 90th percentile, and can potentially describe the entire conditional distribution of the response. It can be viewed as a generation of OLS to a collection of models with different conditional quantile functions. It seeks to measure the marginal effects of explanatory variables by estimating regression coefficients. It express the marginal effects of the explanatory variable on the explained variable in a specific quantile. Therefore, quantile regressions make it possible to analyze the levels of the impact of the explanatory variable on the explained variable in different quantiles.

The least squares estimate minimizes $\sum_i e_i^2$,the sum of the squared error terms and it is enable to estimate models for conditional mean functions. The response y_i for the ith observation is continuous, and the predictors $x_i1, ..., x_ip$ represent main effects that consist of continuous or classification variables and their interactions or constructed effects. Median regression, also known as least-absolute-deviations (LAD) regression, minimizes $\sum_i |e_i|$. Comparatively quantile regression minimizes a weighted sum of the positive and negative error terms that gives asymmetric penalties (1-q)$|e_i|$ for over-prediction and $q|e_i|$ for under-prediction. If the quantile q differs from 0.5, there is an asymmetric penalty, with increasing asymmetry as q approaches 0 or 1.

Quantile regression does not assume a particular parametric distribution for the response, nor does it assume a constant variance for the response, unlike least squares regression. Also least squares regression focus on the conditional mean function E[Y|X] that describes the relationship between Y and X, but it does not capture the conditional variance Var[Y|X], much less the conditional distribution of Y given X. Although its computation requires linear programming methods, the quantile regression estimator is asymptotically normally distributed.

Least squares estimation of mean regression models asks the question, "How does the conditional mean of Y depend on the covariates X?" Quantile regression asks this question at each quantile of the conditional distribution enabling one to obtain a more complete description of how the conditional distribution of Y given X=x depends on x. Rather than assuming that covariates shift only the location

or scale of the conditional distribution, quantile regression methods enable one to explore potential effects on the shape of the distribution as well.

The increasing complexity of data in research and business analytics requires versatile, robust and scalable methods of building explanatory and predictive statistical models. Quantile regression is a highly versatile statistical modeling approach and meets these requirements by fitting conditional quantiles of the response with a general linear model without assuming a parametric conditional distribution of the response. Moreover gives information that it would not obtain directly from standard regression methods. Quantile regression yields valuable insights in applications such as risk management, where answers to important questions lie in modeling the tails of the conditional distribution. Also it is practical and advantageous for large data. Furthermore, quantile regression is capable of modeling the entire conditional distribution, this is essential for ranking.

Quantile regression refers to fractions and is a statistical technique that offer a mechanism for estimating models for the conditional median function and the full range of other conditional quantile functions. Essentially is the extension of linear regression and it used when the conditions of linear regression are not applicable. This regression explore different aspects of the relationship between the dependent variable and the independent variables, and gives a more comprehensive picture of the effect in this relationship by producing different effects along the distribution (quantiles) of the dependent variable.

There are regression coefficients that estimate an independent variable's effect on a specified quantile of the dependent variable. Where dependent variable is continuous with no zeros or too many repeated values. These estimated coefficients (slopes) of the QR can be employed to test alternative hypotheses about the impact of changes in X on the conditional distribution of Y. Among these, the more relevant are those of global equality and symmetry of slopes. Also is capable of providing a more complete statistical analysis of the stochastic relationships among random variables. In addition, quantile regression makes no assumptions about the distribution of the residuals. The mean of the variable of interest differs depending on other variables. But we don't have to always estimate the conditional mean. We could estimate the median, or the 0.25 quantile, or the 0.90 quantile, or some other percent of quantile. That's where quantile regression comes in.

The quantile level is the probability (or the proportion of the population) that is associated with a quantile. The quantile level is often denoted by the Greek letter τ, and the corresponding conditional quantile of Y given X is often written as $\mathrm{Q}_\tau(\mathrm{Y}|\mathrm{X})$. The quantile level is the probability $\Pr[\mathrm{Y} \leq \ Q_\tau(Y|X)|X]$, and it is the value of Y below which the proportion of the conditional response population is τ.

By fitting a series of regression models for a grid of values of in the interval (0, 1), you can describe the entire conditional distribution of the response. The optimal grid choice depends on the data, and the more data you have, the more detail you can capture in the conditional distribution.

Quantile regression gives a principled alternative to the usual practice of stabilizing the variance of heteroscedastic data with a monotone transformation h(Y) before fitting a standard regression model. Depending on the data, it is often not possible to find a simple transformation that satisfies the assumption of constant

variance.

Although quantile regression methods are usually applied to continuous-response data, it is possible to utilize them in the context of count data, such as would appear in a Poisson or negative binomial model. But usually the mathematical forms arising from quantile regression leads to problems in linear programming that can be solved by the simplex method.

The advantages of quantile regression are the estimates in quantile are more robust against to non-normal errors and outliers in the response measurements. Different measures of central tendency and statistical dispersion can be useful to obtain a more comprehensive analysis of the relationship between variables. Moreover quantile regression is well suited for capturing a potentially non-linear relationship between Y and X globally. Also quantile process plots reveal the effects of predictors on different parts of the response distribution.

Quantile process regression estimates the entire conditional distribution of the response, and it allows the shape of the distribution to depend on the predictors, without making any assumption about the distribution of errors. It can be used to provide a richer characterization of the data, allowing us to consider the impact of a covariate on the entire distribution of y (study the distributional relationships of variables), not merely its conditional mean and for the detection of heteroscedasticity. The QR estimator is asymptotically normal with a variance-covariance estimator (VCE), but the expression for the VCE is awkwand to estimate. Furthermore, QR estimator is invariant to monotonic transformation of the data, and the inverse transformation may be used to translate the results back to y.

In the quantile regression approach the τ can be obtained by solving the following minimization problem:

$$\hat{q}_\tau = arg\, min_{q \in R^k} \sum_{i=1}^{N} \rho_\tau (Y_i - q) \tag{1}$$

where $0 < \tau < 1$, ρ_τ is the tilted absolute value function and $k = dim(\beta_q)$.

Now, let's assume that the conditional τ-quantile function is $Q_{Y|X}(\tau) = X\beta_\tau$.

Given a sample of observations (Y_i, X_i) with i=1,2,...N as well as the distribution function of Y, the estimated value of β_τ van be obtained by solving:

$$\hat{\beta_\tau} = arg\, min_{\beta_\tau \in R^k} \sum_{i=1}^{N} \rho_\tau (Y_i - X_i \beta_\tau) \tag{2}$$

The minimization problem of equation 2 can be reformulated and solve efficiently as a linear programming problem:

$$\hat{\beta_\tau} = min_{\beta_\tau \in R^k} \sum_{i:Y_i \geq X_i \beta_\tau} \tau |Y_i - X_i \beta_\tau| + \sum_{i:Y_i \geq X_i \beta_\tau} (1-\tau) |Y_i - X_i \beta_\tau| \tag{3}$$

For $\tau \in$ (0,1) and under some regularity conditions, $\hat{\beta_\tau}$ is asymptotically normal:

$$\sqrt{N}(\hat{\beta_\tau} - \beta_\tau) \xrightarrow{d} N(0, \tau(1-\tau)\, D^{-1} \Omega_x D^{-1}) \tag{4}$$

where

$$D = E(f_y(X\beta)XX^{'}) \; and \; \Omega_x = E(X^{'}X) \tag{5}$$

with f_y being the probability distribution function.

Estimation of the asymptotic variance-covariance matrix does not always perform satisfactory. Inference for quantile regression parameters can be made with the regression rank-score tests or with the bootstrap methods. Bootstrap standard errors are often used in place of analytic standard errors. The latter is being utilized by the present study.

5 Empirical Model and Results

I estimate the relationship:

$$volume \; change = g\,(price \; change) \tag{6}$$

,where price change is $dlnP$ and volume change is $dlnQ$. The g is a potentially non-linear and unknown function.

It is examined the possible existance of a V-shape or a U-shape relationship between $dlnP$ and $dlnQ$. In order to do that, the independent variable of price returns has been split to positive and negative values. As Fousekis and Tzaferi (2019) point out, assuming that the slopes are the same under positive and negative price returns may lead to biased conclusions about the strenght and the pattern of co-movement.

Tables 4-6 presents the empirical findings for the cases of lean hogs, live cattle and feeder cattle.

For lean hogs (Table 4) and under positive price returns, the slopes are negative and non-significant at the low quantiles of volume changes and positive and strongly significant at the high quantiles. The null hypothesis of global equality of slopes is strongly rejected and so is the symmetry in all quantile pairs. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes. The null of global equality of slopes is rejected at the 1% level or less. Symmetry in quantile pairs is rejected at the 1% or 5% level for all pairs except for the pair 40%-60%.

Table 4: Quantile regression results for lean hogs

	Coefficients (dlnP>0)	Coefficients (dlnP<0)
Quantiles:		
5%	-2.46367	-9.73006***
10%	-1.00066	-10.25123***
20%	7.84453**	-10.28974 ***
30%	8.59216***	-9.83506***
40%	11.45872***	-11.24427***
50%	13.99938***	-12.29283***
60%	16.38112***	-12.85826***
70%	19.19843***	-13.17418***
80%	26.45839***	-15.09679***
90%	30.77687***	-22.72002***
95%	46.76211***	-34.84037***
	p-values	p-values
Global equality of slopes	< 0.01	< 0.01
Test for slope equality (H_0: symmetry):	p-values	p-values
5% and 95%	< 0.01	< 0.01
10% and 90%	< 0.01	0.047
20% and 80%	< 0.01	<0.01
30% and 70%	< 0.01	0.047
40% and 60%	< 0.01	0.093

(***, **) : 1% and 5% levels of significance, respectively.
Results were obtained with the bootstrap method after 1000 replications.

For live cattle (Table 5) and under positive price returns, the slopes are positive and significant at all quantile levels. The null hypothesis of global equality of slopes is not rejected. Symmetry in quantile pairs is rejected only for the pair 5%-95%. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes. The null of global equality of slopes is rejected at the 1% or 5% level in all quantile pairs. Symmetry in quantile pairs is rejected at the 1% or 5% level for all pairs.

Table 5: Quantile regression results for live cattle

	Coefficients (dlnP>0)	Coefficients (dlnP<0)
Quantiles:		
5%	12.66675**	-9.48802**
10%	14.36981***	-12.80254***
20%	15.86122***	-14.89580***
30%	13.95225***	-17.45898***
40%	13.81456***	-20.78982***
50%	15.29663***	-22.55439
60%	13.91592***	-26.64774***
70%	14.50876***	-35.59940***
80%	14.22264***	-46.08493***
90%	21.83892**	-56.11249
	p-values	p-values
Global equality of slopes	0.557	< 0.01
Test for slope equality (H_0: symmetry):	p-values	p-values
5% and 95%	0.038	<0.01
10% and 90%	0.332	<0.01
20% and 80%	0.630	<0.01
30% and 70%	0.811	<0.01
40% and 60%	0.954	0.044

(***, **) : 1% and 5% levels of significance, respectively.
Results were obtained with the bootstrap method after 1000 replications.

For feeder cattle (Table 6) and under positive price returns, the slopes are positive and significant at all quantile levels. The null hypothesis of global equality of slopes cannot be rejected at the 1% or 5% level of significance but is rejected at the 10% level. Symmetry in quantile pairs cannot be rejected for the pairs 30%-70% and 40%-60%. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes. The null of global equality of slopes is rejected at the 1% or 5% level in all quantile pairs. Symmetry in quantile pairs is rejected at the 1% or 5% level for all pairs except for the pairs 30%-70% and 40%-60%.

Table 6: Quantile regression results for feeder cattle

	Coefficients (dlnP>0)	Coefficients (dlnP<0)
Quantiles:		
5%	17.44077***	-15.26762***
10%	15.77227***	-16.84520***
20%	15.52849***	-18.67545***
30%	18.54726***	-20.72600***
40%	18.03151***	-24.72070***
50%	17.36375***	-26.59555***
60%	20.09379***	-24.93010***
70%	20.56667***	-26.20126***
80%	27.11284***	-27.44947***
90%	34.41631***	-35.50761***
	p-values	p-values
Global equality of slopes	0.073	< 0.01
Test for slope equality (H_0: symmetry):	p-values	p-values
5% and 95%	<0.01	<0.01
10% and 90%	<0.01	<0.01
20% and 80%	<0.01	0.012
30% and 70%	0.540	0.069
40% and 60%	0.232	0.924

(***, **) : 1% and 5% levels of significance, respectively.
Results were obtained with the bootstrap method after 1000 replications.

The statistical significance of all the slope estimates at every quantile level, under both positive and negative price returns, are in agreement with the results obtained by Wang et al. (2018). On the other hand, in the work by Fousekis and Tzaferi (2019) and in the majority of futures contracts in agricultural commodities, the estimates of the slopes are statistically non-significant at the lower quantiles of the dependent variable ($dlnQ$).

The empirical results reported in Tables 4 - 6 present some similarities. These can be summarized as:

(a) There is positive co-movement under positive price returns and negative co-movement under negative price returns,

(b) Co-movement is weaker at the low quantiles of the dependent variable, both under positive and negative price returns, and

(c) The intensity of co-movement, as expressed by the absolute value of slopes,

increases as the level of quantile increases, both under positive and under negative price returns.

The latter, along with the rejection of slope symmetry in the majority of the quantiles pairs tested, points to asymmetric co-movement at different quantile levels.

The empirical findings of the present study are closely related with the theoretical results by Blume et al. (1994) and with the empirical results by Fousekis and Tzaferi (2019). Both studies suggest that price returns and volume changes are related in a non-linear fashion. The former study suggests a V-shape relationship and the latter suggests a U-shape relationship. Under the V-shape, the strength remains constant. Under the U-shape, the strength is higher at the high quantiles relative to the lower quantiles.

In the present study, co-movement is weaker at the lower quantiles and stronger at the higher quantiles, both under positive and negative price returns. Hence, a U-shaped line would be more appropriate to capture the relationship between the rates of change between prices and trading volume.

More specifically, for the case of lean hogs, a non-linear U-shaped function would be more appropriate to describe the relationship between $dlnP$ and $dlnQ$: the null hypothesis of global equality of slopes is soundly rejected and the flat section of the U-shaped line points to statistically non-significant relation at the low quantiles of $dlnQ$ for $dlnp>0$.

For the case of live cattle, the null hypothesis of global equality of slopes is not rejected for positive price returns. Furthermore, slopes are statistically significant at all quantile levels for both positive and negative price returns. Hence, there would be no flat section to the line of the convex function. Accordingly, a U-shaped line with a non-flat section would be more appropriate to describe the relationship between $dlnP$ and $dlnQ$.

For the case of feeder cattle, the null hypothesis of global equality of slopes for positive price returns is not rejected at the 1% and 5% levels. It is rejected though at the 10% level of significance. Additionally, slopes are statistically significant at all quantile levels for both positive and negative price returns which would indicate no flat sections. Accordingly, a U-shaped line with a non-flat section would be more appropriate to describe the relationship between $dlnP$ and $dlnQ$.

Figures 7 - 12 present diagrammatically the linear OLS estimated coefficients as compared to the estimated coefficients obtained from the quantile regression methodology. More specifically, the red horizontal line is the OLS regression coefficients (intercept and X = slope). The red dashed line is the 95% confidence interval. The OLS coefficients are flat because they don't vary across the quantiles. The black dashed line are the coefficients obtained from the quantile regression models. The gray areas are the confidence intervals.

For the case of lean hogs and under positive price returns (Figure 7), the estimated slopes of the quantile coefficients are significantly lower than the OLS coefficient at the lower quantiles and significantly higher than the OLS coefficient at the higher quantiles. Under negative price returns (Figure 8), the estimated slopes of the quantile coefficients are higher than the OLS coefficient at the lower quantiles and significantly lower than the OLS coefficient at the higher quantiles.

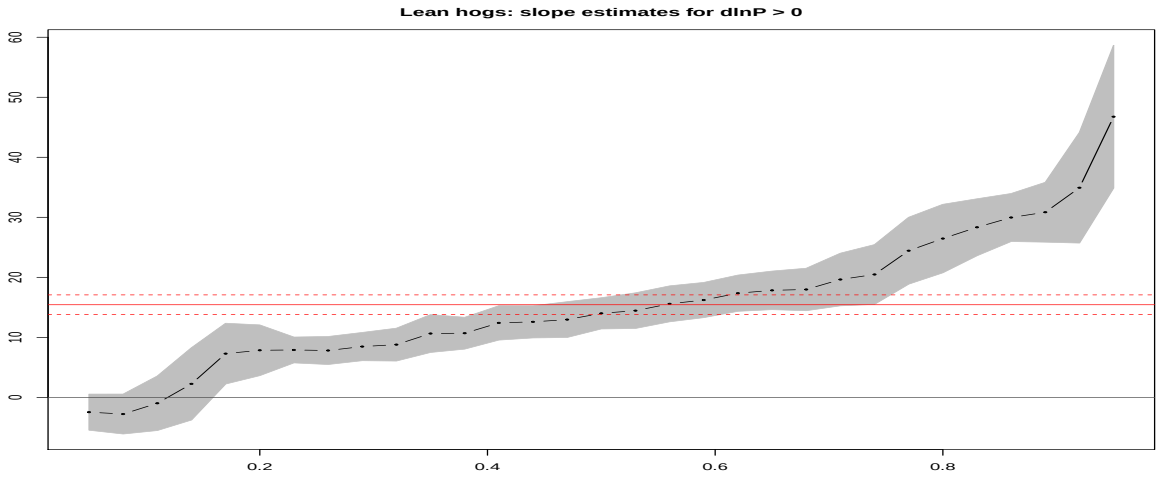

Figure 7: Lean hogs: slope estimates for positive price changes.

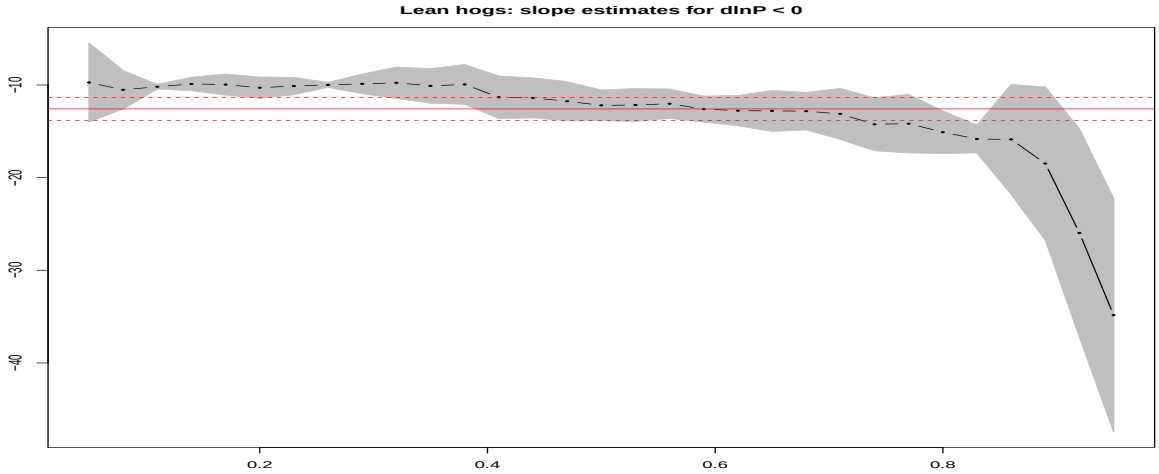

Figure 8: Lean hogs: slope estimates for negative price changes.

For the case of live cattle and under positive price returns (Figure 9), the estimated slopes of the quantile coefficients are significantly lower than the OLS coefficient throughout all the quantile levels. And under negative price returns (Figures 10), the estimated slopes of the quantile coefficients are significantly higher than the OLS coefficient up to the quantile level that is equal to 0.7. Then the estimated slopes of the quantile coefficients are significantly lower than the OLS coefficient.

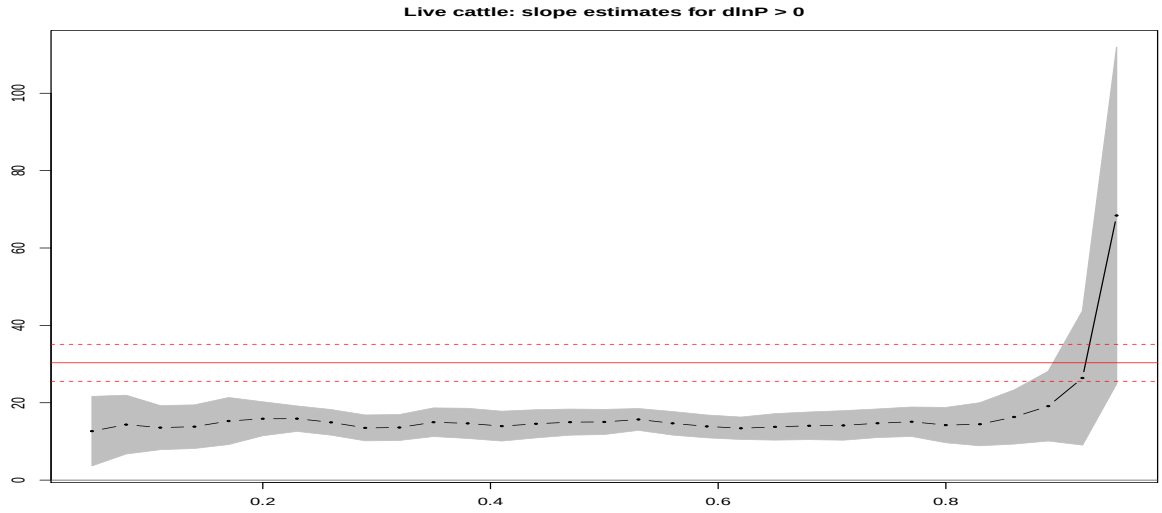

Figure 9: Live cattle: slope estimates for positive price changes.

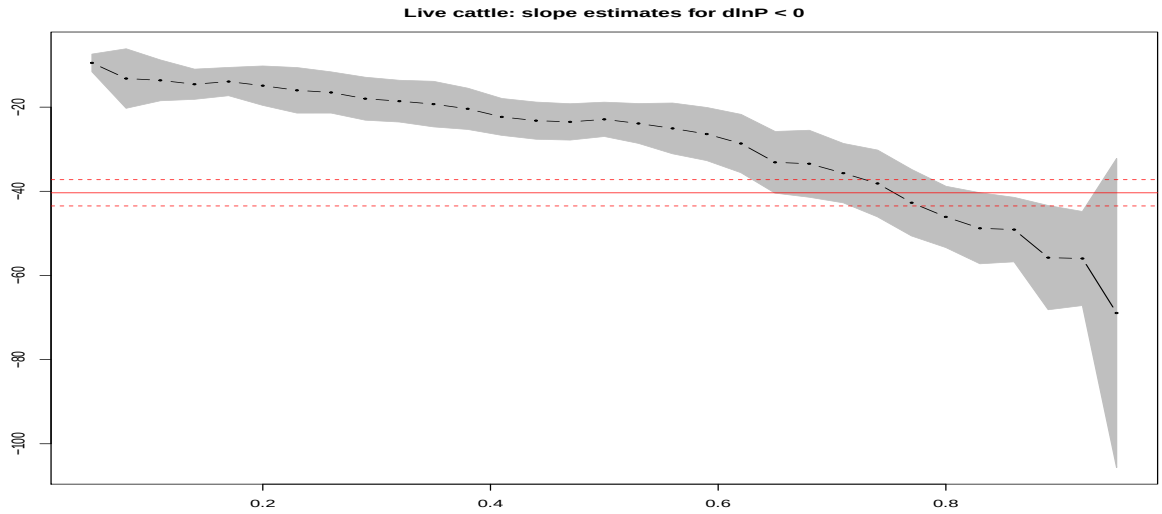

Figure 10: Live cattle: slope estimates for negative price changes.

For the case of feeder cattle and under positive price returns (Figure 11), the estimated slopes of the quantile coefficients are significantly lower than the OLS coefficient up to the 0.7 quantile level. In the higher quantile levels, the estimated slopes of the quantile coefficients are significantly higher than the OLS coefficient. Under negative price returns (Figures 12), the estimated slopes of the quantile coefficients are significantly higher than the OLS coefficient at the lower quantiles. Afterwards the slopes of the quantile coefficients assume values that are almost equal to the OLS coefficient and after the 0.8 quantile level they assume significant higher values than the OLS coefficient.

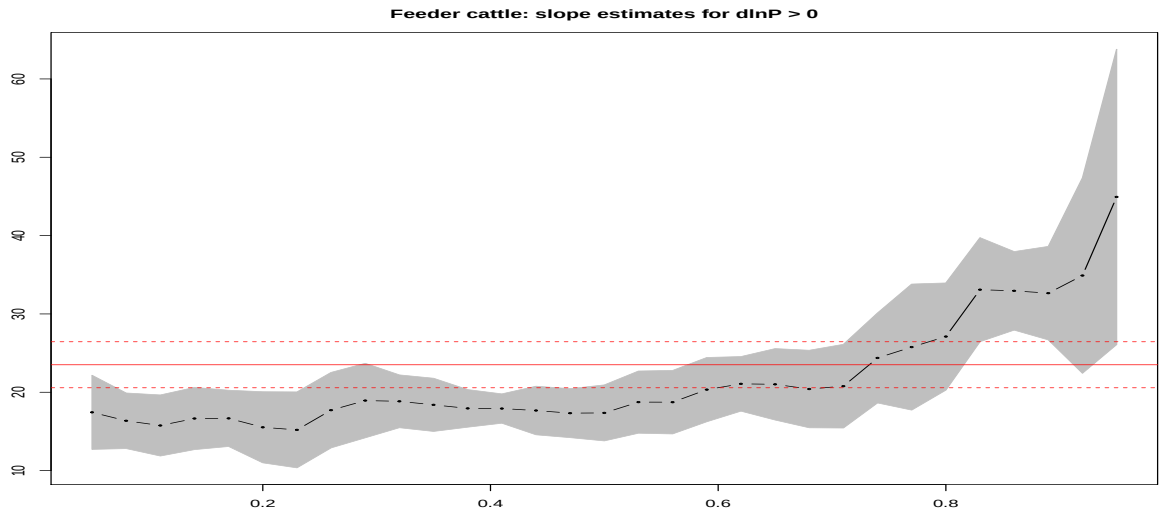

Figure 11: Feeder cattle: slope estimates for positive price changes.

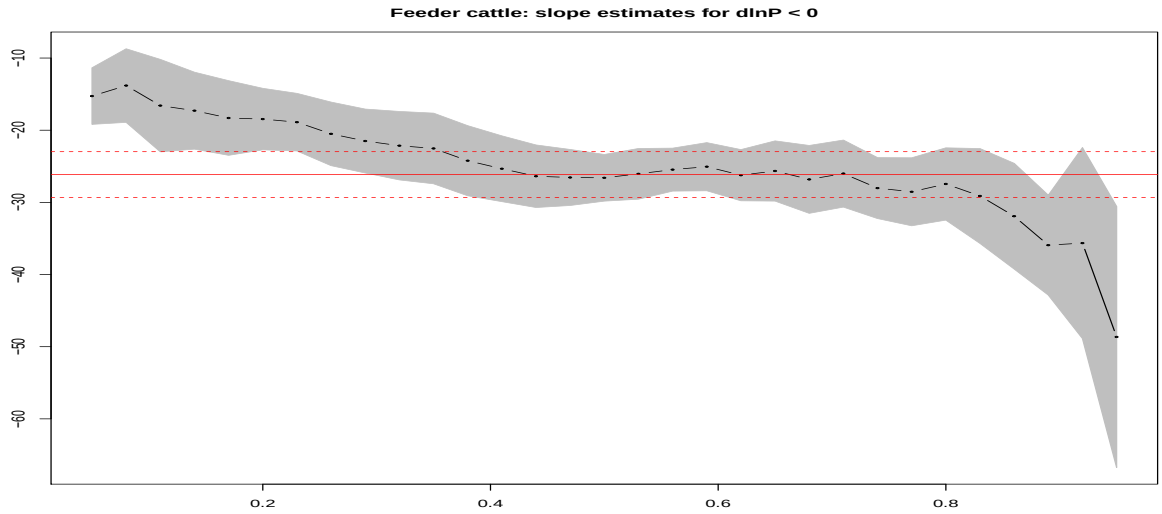

Figure 12: Feeder cattle: slope estimates for negative price changes.

6 Conclusions

Trading commodity futures allow big profits but is volatile and risky, it is rarely suitable for individual investors or retail customers. Because of frequently changes in supply and demand, volatility in commodities tends to be higher than for stocks, bonds, and other types of assets. There are pros and cons in every commodity investment. The pros are that it is the most direct way to invest in commodities and there is a possibility for strong returns. It perform well on a large scale and avoids the burden of physical ownership if you so choose. On the other hand some people find the vast quantities of a commodity that most futures contracts cover to be more exposure than they need, major institutions like the fact that they can

obtain massive amounts of a desired commodity with relatively little effort. Also there is possibility for heavy losses and the minimum deposits necessary.

Futures are the oldest way of investing in commodities. The world's first commodities arose from agriculture practices (crop production and raising livestock). At every stage of the livestock production chain, from birth to feeding, and processing to packing, market participants face the risk of adverse price movements caused by the twists of the market and supply and demand. The livestock market can expose the investors to risks that could affect profitability. Livestock futures and options provide a safety against the risk, as well as to take advantage of potential profit opportunities and is an economic buffer in some economies which may have problems with droughts, markets and other factors. It considered also as a diversification strategy.

The livestock industry is a global market, with livestock and meat being produced, processed and consumed. The beef industry is global with an enormous economic impact. It considers as the basis of a multi billion-dollar industry worldwide. Livestock provide a variety of food and nonfood products and is commonly defined as domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, wool, pharmaceuticals, bone products, industrial protein, and fats. Very little animal biomass may be wasted at slaughter. Also the intestinal contents can be use as fertilizer. Moreover cattle has many uses the most common are for food but many other by-products produced by that. Only the meat and poultry industry approximately offers 5.4 million jobs, $257 billion in wages and 527,019 people have jobs.

The major concentration of the market is at the slaughter and meat processing phase, with only four companies having 81 percent of cows, 73 percent of sheep, 57 percent of pigs and 50 percent of chickens. The top States in Livestock and Poultry slaughtering are for cattle at Nebraska, Kansas, Texas, Colorado, California, Wisconsin, Washington and Pennsylvania. For hog are at Iowa, Minnesota, Illinois, Indiana, Missouri, Oklahoma and Pennsylvania.

Livestock traders distinguish between two types of cattle – feeder cattle and live cattle. The difference between these two commodities is the stage of the production cycle. Live Cattle and Feeder Cattle futures and options serve commodity producers and users seeking risk management and hedging tools. Live Cattle are physically delivered contracts, while Feeder Cattle are cash-settled contracts.

Feeder Cattle futures contracts allow investor, to hedge in price between the time calves are born and when they are sold to feedlots. The states with the bigger production are Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas and Wyoming. On the other hand, Live Cattle futures are designed to allow to hedge against a decline in price before they are able to sell the cattle for processing, and for buyers, such as meat packers, to manage the risk of an increase in the price of the cattle they are planning to purchase for processing, or to protect their profit margin for beef they have committed to ship in the future. The seven major cattle producing states are Arizona, California, Colorado, Iowa, Kansas, Nebraska, and Texas. The U.S. pork industry is big business and risky, it affected by many factors as weather and disease. The benefits of Lean Hog futures allow investors, such hog producers and packers, to

reduce the risk of price movements, access to electronic markets and arbitrage and spread opportunities with other commodities, such as grains. Lean Hogs in United States are produced mostly in Iowa, Minnesota, North Carolina and Illinois.

Trading volume in the markets of livestock futures contracts has increased sharply in the last thirty years. As a consequence, the empirical examination of the relationship between trading volume and price has been a increasingly investigated topic.

The objective of the present study is to empirically examine the relationship between rates of change in closing prices and trading volume in the livestock futures markets with the use of quantile regression. Quantile regression models offer great flexibility to the researcher since they can capture possible non-linearities in the relationship between the dependent and the independent variable(s). The advantages of quantile regression are the estimates in quantile are more robust against to non-normal errors and outliers in the response measurements. Different measures of central tendency and statistical dispersion can be useful to obtain a more comprehensive analysis of the relationship between variables. Moreover quantile regression is well suited for capturing a potentially non-linear relationship between Y and X globally. Also quantile process plots reveal the effects of predictors on different parts of the response distribution.

The empirical findings of the study reveal asymmetric co-movement between price and trading volume for different quantile levels. More specifically, co-movement is stronger at the higher quantiles of the dependent variable than it is at lower quantiles, both under positive and negative rates of price returns.

For lean hogs and under positive price returns, the slopes are negative and non-significant at the low quantiles of volume changes and positive and strongly significant at the high quantiles. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes. For live cattle and under positive price returns, the slopes are positive and significant at all quantile levels. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes. For feeder cattle and under positive price returns, the slopes are positive and significant at all quantile levels. Under negative price returns, the slopes are negative and significant at all quantile levels of volume changes.

Furthermore, the intensity of co-movement, as expressed by the absolute value of slopes, increases as the level of quantile increases, both under positive and under negative price returns. The pattern of co-movement is a possible U-shaped line with a potential flat section in the neighborhood of the low quantiles for the case of lean hogs. For the case of the futures contracts in the commodities of live cattle and feeder cattle, an asymmetric V-shaped line might capture better the relationship between the rates of change in closing prices and the rates of change in trading volume.

The present study appears to be the first that has considered the relationship between trading volume changes and changes in price returns in the livestock futures markets while allowing for non-linearities. Given the growing importance of futures contracts in the livestock commodities for buyers-sellers as well as hedgers and speculators, future research is guaranteed. Parametric/non-parametric copulas, and parametric/non-parametric regressions that can capture non-linearities can be a possible future avenue that will shed more light on the topic.

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