Mountain Plains Journal of Business and Technology

Volume 24 | Issue 1 Article 5

Date Published November 2023
Date Submitted 2023-06-15
Date Accepted 2023-10-22

Manipulation in the Agricultural Commodities Futures Market: Application of Benford's Law

Frank Tenkorang
University of Nebraska at Kearney

Greg Nies
University of Nebraska at Kearney

MANIPULATION IN THE AGRICULTURAL COMMODITIES FUTURES MARKET: APPLICATION OF BENFORD'S LAW[1]

FRANK TENKORANG
UNIVERSITY OF NEBRASKA AT KEARNEY

GREG NIES
UNIVERSITY OF NEBRASKA AT KEARNEY

ABSTRACT

This paper proposes that Benford's Law is an effective tool for determining futures market irregularities and therefore should be adopted and used in efforts to detect and prevent manipulation in the agriculture commodities futures market. Market manipulation, while hard to define and even harder to detect and prevent, has long been a concern for traders and regulators alike. Market power manipulation – the intentional use of monopolistic power to cause market prices to diverge from their competitive level – harms the market by eroding its efficiency and impairing market integrity thereby driving away potential traders and ultimately undermining financial markets, investments, and the economy as a whole. An effective, accurate, and readily understood economic analysis method for easy detection of market manipulation is needed. This paper examines the data from the alleged 1989 Ferruzzi soybean futures market "squeeze" with the hypothesis that a deviation from uniform price distribution should be found in 1989. Through the application of Benford's Law, this paper confirmed the existence of market manipulation in May of 1989. Moreover, the findings further suggest: 1) the possibility of manipulation in the soybean futures market in 1987 and 1988 prior to the Ferruzzi incident, 2) that the Chicago Board of Trade's forced liquidation orders prevented or minimized the effects of the Ferruzzi squeeze in July of 1989, and 3) Benford's Law is an effective method for detecting futures market irregularities and therefore promises to be a potentially useful tool in the early detection and prevention of market power manipulation.

Keywords: manipulation; market manipulation; market power; Benford's Law; Ferruzzi; commodity futures market

INTRODUCTION

The Agricultural commodity futures market has two main roles. Its traditional role is to provide an avenue for commodity stakeholders such as farmers/ranchers, food processors/manufacturers, and merchants to hedge[2] their price risk. The market also serves a nontraditional role whereby outsiders looking to make money can speculate on commodity price swings. While the activities of both hedgers and speculators are necessary for market liquidity and efficiency, their conflicting interests concern some traders. The concern primarily stems from the fact that some traders could attempt to unfairly manipulate the market to their advantage. For example, 34 years ago, a sharp increase in the 1989 July soybean futures price from $7.25 to $7.75

[1] Submitted 15 June 2023; Revised 29 September 2023; Accepted 22 October 2023
[2] Hedgers buy or sell commodities in the cash market and use the futures market to reduce price risk due to price fluctuations. Speculators do not have any interest in the actual commodity and use the futures market to make profit by buying low and selling high.

per bushel within a couple of days (Knight 1989) was blamed on an alleged market manipulation by Ferruzzi Finanzia S.P.A., a major buyer of soybeans. Ferruzzi was able to accumulate a position five times the deliverable supply in July 1989 (Pirrong 2017). Traders in short positions, therefore, found themselves between the proverbial rock and a hard place; they either pay a high price to nullify their short position or pay a high price for the actual commodity to fulfill their contract, both of which benefited Ferruzzi.

While Ferruzzi vehemently denied any wrongdoing in the 1989 incident (Litke 1989), unlawful manipulation still remains at the forefront of futures market discussion because both detecting and prosecuting offenders is extremely difficult. Many studies (Pirrong 2004, Jarrow et al. 2018, Kumar and Seppi 1992) have used different economic analysis methods to detect market manipulation, while others (McDermott 1979, Van Smith, 1981, and Perdue 1987) have tried to redefine manipulation in a manner designed to enhance the prosecution of manipulators. However, fraud detection is often difficult; even auditing financial records with tried and tested sophisticated methods often produces false results. A classic example is the Fairfield Sentry Fund (FSF) investments managed by Bernie Madoff. The owners of FSF described their operation as more transparent than other firms, with low volatility and steady returns. The steady returns and low volatility were all red flags when other investments were experiencing the opposite, yet they went undetected or ignored for years before the Madoff scandal in 2008. Using Benford's Law, Amiram et al. (2015) easily detected irregularities in Fairfield's financial records. This study applies Benford's Law to soybean and corn futures prices and trade volumes in an effort to detect any irregular patterns during the Ferruzzi squeeze. Preliminary results confirm a Ferruzzi squeeze in 1989. Specifically, the results show statistically significant irregularity compared to a uniform distribution.

The next sections of the paper focus on futures market manipulation, the Ferruzzi squeeze, methodology, results, and conclusions.

Futures Market Manipulation

Manipulation of the futures market is one of those concepts that is hard to define with precision, but its occurrence can most certainly be felt. The word “Manipulation,” or a derivative thereof, appears about 100 times in the Commodity Exchange Act but without an express definition (Kolb and Overdahl 2006). Even though perpetrators could face fines of up to $1 million, it has been argued that the lack of a satisfactory definition allowing for a clear determination that an act of unlawful manipulation occurred makes such an occurrence difficult to prosecute (Perdue 1984).

Kolb and Overdahl (2006) describe three market consequences of manipulation: trading at unjustified prices, market inefficiency due to decreased participation, and the inability of hedgers to manage their risk. Fletcher (2018) states that manipulation harms the market by both undermining its efficiency through distorting pricing mechanisms and through impairing the market's integrity causing other market participants to believe the market is unfair. The undermining of financial markets through manipulation has far-reaching negative consequences even beyond the capital markets as it can affect investments, consumer savings, and numerous other aspects of the economy (Fletcher 2018). Due to the seriousness of these consequences, the

Commodity Futures Trading Commission (CFTC) employs a variety of policing mechanisms designed to prevent or mitigate the effects of market manipulation. Tactics include imposing lower contract position limits for speculators, employing real-time surveillance of contracts, and forcing liquidation of positions if manipulation is detected or suspected.

Concerns of manipulation in commodity markets arose as early as the post-Civil War period, eventually resulting in the passage of the Grain Futures Act (GFA) of 1922 and later the Commodities Exchange Act (CEA) of 1936 (Pirrong 2017). The latter Act, still in force today although amended multiple times, established the Commodity Futures Trading Commission, whose mission is to "protect market participants from fraud, manipulation, and abusive practices." (Scopino 2016). While a primary purpose of the CEA has long been the prevention of market manipulation, the Act prohibits a variety of wrongdoing beyond manipulation, including improper and distortive trade practices (such as "wash trades[3]," "spoofing," and "banging the close") and fraud-based distortions (post-2010 Frank-Dodd Act amendments) (Scopino 2016).

The CEA and regulations promulgated pursuant to the Act proscribe specific conduct, including "manipulate(ing) the price" of any commodity (CEA (9(a)(2); 17 CFR 180.2), but do not define the term "manipulate." While some commentators consider this an oversight that makes policing the markets more difficult, other scholars note that because the "methods and techniques of manipulation are limited only by the ingenuity of man," any set definition of illegal manipulation would necessarily have to be expansive enough to evolve with the changing market while still specific enough to provide meaningful boundaries – a tall order indeed (Fletcher 2018). In the absence of a statutory definition provided by Congress, the task of defining manipulation fell to the courts and interested academics. The result is two divergent definitions of market manipulation: economic and legal - each with a slightly different focus.

When examining market manipulation, Economists tend to focus on the resulting economic effects on the market based on an academic understanding. Pirrong (2017) defines manipulation as "intentional conduct that causes market prices to diverge from their competitive level" with the key being price distortion causing inefficient allocation of resources. Others define manipulation as "conduct that creates an extraneous or improper effect on price" or "the elimination of effective price competition in a market for cash commodities or futures contracts through the domination of either supply or demand and the exercise of that domination intentionally to produce artificially high or low prices." (Fletcher 2018). By contrast, the courts pursue a practical approach and tend to rely on identifiable elements that generally include some combination of actions leading to price artificiality and intentional market misconduct (Fletcher 2018). For example, the US Supreme Court has stated manipulation "refers generally to practices . . . that are intended to mislead investors by artificially affecting market activity." (*Santa Fe Indus. Inc.*, 430 US. 476 (1977)). The

[3] Engaging in wash trading involves concurrently buying and selling assets to mislead observers into perceiving heightened market activity.

Spoofing entails the utilization of automated bots to initiate numerous trading contracts but subsequently withdraw or cancel them before their execution, often to manipulate market sentiment.

Banging the close refers to submitting substantial contract orders in the moments leading up to the market's closing, potentially influencing the closing price or settling conditions.

8th Circuit has held that "the test of manipulation must largely be a practical one . . . . The aim must be therefore to discover whether conduct has been intentionally engaged in which has resulted in a price which does not reflect basic forces of supply and demand." (*Cargill, Inc. v. Hardin*, 452 F.2d 1154, 1162 (8th Cir. 1971).

While an agreed definition of market manipulation remains elusive, there is general academic consensus that there are several distinct categories or types of market manipulation, but again there are differences of opinion on what the proper taxonomy should be. Abrantes-Metz (2013) uses the categories: 1) delivery impairment, 2) spreading false information, and 3) market rigging; Scopino (2016) uses the categories: 1) market-power manipulation, 2) noncompetitive trading, 3) disruptive trading, and 4) fraud-based manipulative devices; Fletcher (2018) uses the categories: 1) fraud and misstatements, 2) fictitious trades, and 3) price manipulation; Pirrong (2017) uses the categories: 1) market power manipulation, 2) trade-based manipulation, and 3) information-based manipulation. While the terminology and groupings may differ slightly, all tend to agree that the most prevalent (and therefore perhaps the most detrimental) type of manipulation found within the commodities markets is what is commonly known as market-power manipulation, also termed price manipulation.

This "traditional" or "classic" form of manipulation – market power manipulation - occurs when the manipulator exercises monopoly power in an expiring futures contract and demands excessive deliveries against a futures contract through either a "corner" or a "squeeze." (Pirrong 2017). A squeeze is when a trader acquires a large long (i.e., buy) futures position when there is a shortage of the underlying commodity and therefore takes advantage of a market shock to manipulate the price (Abrantes-Metz 2013). A corner is when a trader has a net long position and owns all or nearly all of the deliverable supply of a particular commodity, thus acquiring and using market power at a monopoly or near-monopoly level to influence the price. (*Cargill* 452 F.2d 1161 (8th Cir. 1971). In both cases, the manipulator is in a position to force the shorts (i.e., sell) to pay artificially high prices as the delivery date approaches in order to settle their accounts. (*Cargill* 452 F.2d 1161 (8th Cir. 1971).

While subject to criticism by economists, the courts have developed a practical and now legally binding definition of traditional market power manipulation based on a trader's actions and intent to affect market price. This four-part test has been enshrined in the common law jurisprudence of commodity manipulation cases for over four decades now, and in 2011 was formally adopted by the CFTC in its rules describing unlawful manipulation. To make a successful claim for market-power/price manipulation all four of the following elements must be proven: 1) the defendant had the ability to influence the market prices, 2) an artificial price existed, 3) the defendant caused the artificial price, and 4) the defendant specifically intended to cause the artificial price (*Frey v. CFTC*, 931 F.2d 1171, 1177 (7th Cir. 1991) (17 CFR 180.2). Accordingly, the current legal, and most practical, definition of market power manipulation is any conduct that meets the above four elements. Note that the last element of the test requires a showing that the alleged manipulator had "specific intent," or carried out the manipulative acts "with the purpose or conscience object of causing or affecting a price or price trend in the market that did not reflect the legitimate forces of supply or demand." (Scopino 2016). This very high burden of proving

motivation behind actions is often cited as the reason the CFTC has successfully prosecuted only one market-power manipulation case in the last four decades (Abrantes-Metz 2013). This four-part test, in use since the early 1980s, was in effect during the Ferruzzi incident and all related litigation.

Ferruzzi Squeeze

Ferruzzi Finanzia S.P.A. subsidiary, Central Soya, was a major buyer of soybeans between 1981 and 1996. It was accused of cornering the soybean futures market in 1989 when it owned most of the soybeans in storage and held 16.2 million bushels of May soybeans futures contracts (Kolb and Overdahl 2006). Even though the Chicago Board of Trade (CBOT) forced it to liquidate its position to 3 million bushels, it rolled them over to the July Futures market instead and held 35% of the open interest (Pirrong 2004). At a point in time, it controlled 7 million bushels of the 8.6 million held by traders. A gradually forced liquidation by CBOT over several days minimized the impact of the alleged manipulation. To further highlight the difficulty in defining, determining, and prosecuting manipulation, it should be noted that although Ferruzzi paid a $2 million fine to CBOT in 1992 to settle CBOT's lawsuit, this payment was not acknowledged as a penalty by the firm (Kolb and Overdahl, 2006) nor did the firm admit any wrongdoing. Moreover, the CFTC never brought charges against Ferruzzi. It is also worth noting that Ferruzzi's actions in 1989 were precipitated by a severe drought in the Midwest of the US resulting in an abnormally low supply of soybeans; hence the alleged manipulation qualifies as a "squeeze."

METHODOLOGY

In addition to finding a reasonable definition and test for determining futures market manipulation, an easy-to-use and understand method of detecting irregularities in the futures market is also imperative to enhance the surveillance efforts of the CFTC and to deter potential manipulation. Most of the methods used in previous studies (concentration analysis by Barnhart et al. 1996, Account-level transaction data by Jarrow et al., 2018, market power detection using error correction model and GARCH by Pirrong 2004)) do not meet these qualities as they tend to be complex and time-consuming. The Benford's Law (1938) method compares the actual distribution of digits to the expected distribution, not the distribution in a different period, which could have suffered from manipulation. Benford's Law has been successfully used to detect irregularities in financial statements (Amiram et al. 2014), regression results (Diekmann 2007), and county-level vote data (Groharing and McCune 2020). Even the IRS uses it as the first attempt (red flag) to detect fraud before deep-diving auditing (Kovalchik 2015). According to the Law, the relative distribution of the first digits (leading digits) of naturally occurring statistical data should have the leading digit distribution pattern in Table 1 below. Substantial deviations from this distribution could serve as a red flag warning of a potential fabrication or manipulation of the data.

Table 1. Benford's Law for Leading and Fourth-Order Digits Probabilities

Digits	0	1	2	3	4	5	6	7	8	9
Leading digit	NA	30.1%	17.6%	12.5%	9.7%	7.9%	6.7%	5.8%	5.1%	4.6%
Fourth digit	10.0%	10.0%	10.0%	10.0%	10.0%	9.9%	9.9%	9.9%	9.9%	9.9%

Source: Nigrini (1996)

The frequencies in the leading digit row of the table are based on the equation below, where *d* is the leading digit.

$$Prob(d) = Log_{10}\,(1 + (1/d))$$

Although Benford's Law, first stated by Newcomb in 1881, applies to many naturally generated numbers, it is hard to explain why it works (Raimi 1985 and Hill 1998). A requirement for the Law to hold is a sufficient dataset without limits on the upper or lower leading digits (Frost undated).

Application to Agricultural Commodities Futures Market

While no natural limits exist on soybean and corn futures prices, the leading digits are inflexible. For instance, daily soybean prices could remain in the 15-dollar range for over a year making the Law inapplicable. Also, daily price limits set by the CME Group (currently at ± $1.00) limit the variability and hence the distribution of the second and third digits, and, similarly, the distribution of the first and second digits of corn price Therefore, in the case of agricultural commodities like soybean and corn, it is implausible to have a sufficient number of leading digits that would match the monotonic decline of Benford's first digit distribution. However, the latter digits also have a unique distribution pattern which could be helpful in agricultural price data. The fourth, for instance, has an approximately uniform distribution (Diekmann 2007). A study by Dlugosz and Muller-Funk (2009) proved this mathematically and found that deviations from that could indicate irregularities in a dataset. Diekmann (2007), using fabricated and published statistical estimates, also found that the latter digits performed better than the first digits in detecting anomalies. Therefore, the last digit of agricultural commodity prices is recommended. We use Kolmogorov-Smirnov (KS) statistics and Chi-square to test uniformity. The KS test statistic is given as

$$\text{KS} = \text{Dn} = \sup_{x} |FE(x) - FO(x)|$$

where FE is the expected distribution (uniform), and FO is the observed distribution (E.g., the distribution of soybean price).

Data

While our primary focus is on the Ferruzzi soybean squeeze, we include corn in the analysis since corn and soybean compete for production resources, are complementary in feed production (USDA 2020 and Hech 2022), and their marketing is closely related. Hence, a possible spillover effect of the soybean squeeze could have been present in the corn market. We use soybean and corn futures' daily trading prices (open, high, low, and close) between the first week of May and the last trading day of the May futures for the earlier trading squeeze and between the last trading day of the May futures and the last trading day of the July futures, for the second squeeze due to the rollover of the May futures to the July futures. Daily trading volumes are also included in the data. In addition to the year of interest, 1989, we analyze the two years prior to the alleged squeeze and the two years after for comparison. We also include the three most recent years of data, 2020-

2022, to understand the current situation. Table 2 below shows the summary statistics of the closing price data used. It is worth noting that the prices were in cents and were not rounded up to the nearest cent. For instance, for $7.1575, we used 715 cents since, technically, the price did not reach $7.16.

Table 2. Summary Statistics of Soybean and Corn Closing Futures Prices (cents)

	Soybean		Corn	
Year	Mean	Coef. of Var.	Mean	Coef. of Var.
1987	554	3.10	184	5.54
1988	882	11.69	275	19.37
1989	722	3.04	263	3.25
1990	611	2.45	283	2.50
1991	561	3.66	247	11.24
1992	604	2.55	239	3.20
2020	865	2.24	328	2.75
2021	1479	5.65	671	5.22
2022	1664	4.12	767	2.83

Source- Futures Trading Charts: 1987-1992; Yahoo Finance: 2020-2022

Both commodities exhibited high volatilities in 1988, followed by a drastic fall the following year. Also, prices increased by over 200% between 1987 and 2022. While the summary statistics cover only daily settlement prices, the analyses include opening, closing, lowest and highest prices, and the daily trade volume.

The last digit of each value mentioned above was extracted using the MS Excel Right function, and their distribution probabilities were used to compute the KS statistics and chi-square test. We hypothesize a deviation from a uniform distribution in 1989. Also, an assertion in JLN (2014) suggests that the Ferruzzi squeeze started before 1989; hence, we also focus on that year. This is particularly interesting as it would indicate the effectiveness of CBOT attempts at detecting manipulations.

RESULTS AND DISCUSSION

The Kolmogorov-Smirnov (KS) statistic and chi-square were used to detect the presence of irregular distribution in soybean and corn futures prices, and the results for soybean and corn are presented in Tables 3 and 4, respectively. The soybean results are consistent between the KS statistics and the chi-square test. The statistically significant chi-square test confirmed the Ferruzzi squeeze in May 1989 but not July, which shows that the gradual liquidation enforced by the CBOT was effective.

Table 3. Kolmogorov-Smirnov and Chi-Square Results for Soybeans

	Kolmogorov-Smirnov		Chi-Square	
Year	May Futures	July Futures	May Futures	July Futures
1987	7.70%	6.60%	11.6	18.11**
1988	9.30%	9.40%	15.89*	22.96***
1989	7.70%	9.00%	18.67**	11.68
1990	6.40%	6.10%	7.85	12.52
1991	14.20%	16.50%	20.20**	27.90***
2020	3.30%	6.90%	2.6	7.69
2021	6.70%	3.80%	7.86	2.98
2022	6.80%	8.10%	9.29	10.48

***p value <0.01, **p value <0.05, *p value < 0.1

The results also show potential irregularity in the prior years; 1988 May and July futures and 1987 July futures. The prior years' results support the notion of irregularity in the market before the 1989 Ferruzzi case (JLN 2014). Also, three years of irregularity detection from July 1987 through May 1989, followed by none in 1990, after the CBOT intervention, suggest potential manipulative activities in those three years.

While the irregularities observed before 1990 are likely due to alleged manipulation, the 1991 irregularities were unexpected. A review of the coefficient of variation in Table 2 and KS in Table 3 shows a positive correlation between variability and KS statistics. So, the KS statistic captures variability in the price, which could be due to any market shock. The only significant event in the 1990/91 period was the passing of the 1990 Farm Bill, which brought the national mandatory soybean checkoff program (Kaiser 2019). If no trader attempted to manipulate the market, the checkoff program likely had some initial shock effect. The last three years' results do not show irregularities.

As anticipated, the irregularities observed in the corn futures prices mimic those in the soybean futures prices. For example, 1987 and 1988 had statistically significant irregularities. However, although the 1989 chi-square was relatively large, it was not statistically significant. The last three years' results are also similar, except for May 2022, which has a significant irregularity. This irregularity could be attributed to the substantial fluctuation in prices from $8.02 on May 2 to $7.84 on May 6, up to $8.09 on May 16, and then down to $7.78 four days later.

Table 4. Kolmogorov-Smirnov and Chi-Square Results for Corn

	Kolmogorov-Smirnov		Chi-Square	
Year	May Futures	July Futures	May Futures	July Futures
1987	10.00%	8.00%	22.51***	20.92**
1988	11.50%	11.30%	17.57**	24.49***
1989	11.30%	3.10%	14.22	7.94
1990	11.30%	5.50%	12.44	8.72
1991	25.30%	8.60%	50.99***	8.4
2020	14.80%	3.70%	13.78	2.47
2021	9.80%	3.90%	11.99	10.37
2022	7.37%	7.00%	20.31**	7.21

***p value <0.01, **p value <0.05, *p value < 0.1

SUMMARY AND CONCLUSION

Many potential commodities futures market traders have stayed out of the market due to mistrust from suspected manipulation. This distrust in the fairness of the market is heightened by the difficulty of detecting bad actors and successfully prosecuting offenders. Despite its inexplicable underlying properties, Benford's Law does an excellent job detecting data irregularities. Its application to soybean and corn futures market data produced some exciting results making it a potential early warning tool in detecting market manipulation. It is a straightforward and rapid method and could be applied regularly to monitor the market for suspicious activities. We draw the same conclusion as Pirrong (2004), who used a more extensive method to detect the existence of market power manipulation and attributed the manipulation in the 1989 soybean futures market to Ferruzzi's behavior. Our study separately investigated potential manipulation in the May and July 1989 contracts and covered the corn futures market for a potential cross-effect. Finally, we applied our method to other years, before and after 1989, for validation.

Our results highlight three issues. First, they question whether Ferruzzi or another firm possibly manipulated the futures market before 1989. The combined 1987, 1988, and 1989 results indicate potential manipulation except in July 1989. Second, the results indicate that the forced CBOT liquidation in July 1989 effectively prevented or minimized the impact of the Ferruzzi squeeze. Lastly, our results show that Benford's Law effectively detects futures market irregularities. Moreover, these results reinforce the conclusions revealed in the literature review that early detection of manipulation is critical.

This paper contributes to the methods of detecting manipulation literature and, consequently, instills confidence in the futures market. A more precise, more comprehensive understanding of manipulation (McDermott 1979) and relatively easy-to-apply economic analysis (Perdue 1987) is needed to prosecute offenders and increase participation in the futures market. The Federal courts' four-pronged test adopted by the CFTC provides a practical framework for determining if an unlawful market manipulation has occurred but falls short standing alone. For

example, prong two of the test requires proving that an “artificial price existed.” Accurate data and a proper economic analysis are necessary to support such a finding. While a succinct and easy-to-apply universal definition of manipulation remains elusive, we suggest an improved standard should account for "easy detection" of market manipulation using easy-to-understand methods. Finally, it is worth noting that while Benford’s Law does not capture the intent of the trader and the reason for choosing the alleged squeeze instead of a different method, the primary and obvious intent of Ferruzzi was to gain the highest price possible.

REFERENCES

Abrantes-Metz, R. M., Rauterberg, G., & Verstein, A. (2012). Revolution in manipulation law: The new CFTC rules and the urgent need for economic and empirical analyses. *U. Pa. J. Bus. L.*, *15*, 357.

Amiram, D., Bozanic, Z., and Rouen, E. (2015), "Financial Statement Errors: Evidence from the Distributional Properties of Financial Statement Numbers." Review of Accounting Studies, 20(4), pp 1540-1593.

Barnhart, S.W., Kahl, K.H., and Barnhart, C.M. (1996). An Empirical Analysis of the Alleged Manipulation Attempt and Forced Liquidation of the July 1989 Soybean Futures Contract, in The Journal of Futures Markets, 16(7), pp. 781-808.

Benford, F. (1938), "The Law of Anomalous Numbers," Proc. Amer. Philosophical Soc. 78, 551–572.

Diekmann, A. (2007) Not the First Digit! Using Benford's Law to Detect Fraudulent Scientific Data, in Journal of Applied Statistics, 34(3), pp. 321-329.

Dlugosz, S., Müller-Funk, U. (2009), "The value of the last digit: statistical fraud detection with digit analysis." Adv Data Anal Classif, 3, pp. 281 https://doi.org/10.1007/s11634-009-0048-5

Fletcher, G. G. S. (2018). Legitimate Yet Manipulative: The Conundrum of Open-Market Manipulation. *Duke LJ*, *68*, 479.

Frost, J. (undated), Benford's Law Explained with Examples Statistics by Jim, https://statisticsbyjim.com/probability/benfords-law/

Groharing, B. and McCune, D. (2020). Benford's Law and County-Level Votes in US Presidential Elections, in Chance. https://chance.amstat.org/2022/04/benfords-law-votes/ Accessed February, 20, 2023.

Hecht, A. (2022), "Why Grain Investors Should Watch Corn-Soybean Price Spread." Investing.com. https://www.investing.com/analysis/why-grain-investors-should-watch-cornsoybean-price-spread-200614549

Hill, T. P. (1998), "The First Digit Phenomenon: A century-old observation about an unexpected pattern in many numerical tables applies to the stock market, census statistics and accounting data." American Scientist, 86(4), pp. 358-363.

Jarrow, R., Fung, S., and Tsai, S-C. (2018), "An empirical investigation of large trader market manipulation in derivatives markets." Review of Derivatives Research, 21, pp 331-374.

JLN (2014), Get Shorty: The Year Ferruzzi Spun A Soybean Tale. John Lothian News. https://johnlothiannews.com/get-shorty-year-ferruzzi-spun-soybean-tale/

Kaiser, H.M. (2019). An Economic Analysis of the United Soybean Board's Demand- and Supply-Enhancing Programs (2014-2018); preliminary draft.

Kern, J. (1987), "Price manipulation in the commodity futures markets: reexamination of the jurisdictions for simultaneous causes of action under the CEA and the Sherman Act." UCLA Law Review, 34(4), 1305-[ii].

Knight, J. (1989, July 18), "The Great Soybean Squeeze Puts the Board of Trade in a Corner of Its Own." Knight, J (1989). The Washington Post. https://www.washingtonpost.com/archive/business/1989/07/18/the-great-soybean-squeeze-puts-the-board-of-trade-in-a-corner-of-its-own/ac514029-e898-48a2-982a-0dbbe2426847/

Kolb, R.W. and Overdahl, J.A. (2006), "Understanding Futures Markets." Blackwell Publishing.

Kovalchik, K. (2015), The IRS's Favorite Mathematical Law, Mental Floss.

Kumar, P and Seppi, D. (1992). Manipulation with "Cash Settlement" in The Journal of Finance, 47(4), pp 1485-1502.

Litke, J. (1989), "Italian Firm Denies It Attempted to Corner Soybean Market, Sues CBOT." AP News, July 13, 1989 https://apnews.com/article/55c7a793254f8d5e76e5f3cea123f10c

McDermott, E.T. (1979). Defining Manipulation in Commodity Futures Trading: The Futures "Squeeze," in Northwestern University Law Review, 74(2), pp 202-225.

Newcomb, S. (1881), "Note on the Frequency of Use of the Different Digits in Natural Numbers," Amer. J. Math. 4(1), 39–40.

Nigrini, M. J. (1996), "A taxpayer compliance application of Benford's Law." The Journal of the American Taxpayer Association, 18, pp. 72–91.

Perdue, W.C. (1987). Manipulation of Futures Markets: Redefining the Offense in Fordham Law Review, 56(3).

Pirrong, C. (2017). The economics of commodity market manipulation: A survey. *Journal of Commodity Markets*, *5*, 1-17.

Pirrong, C. (2004). Detecting Manipulation in Futures Markets: The Ferruzzi Soybean Episode. American Law and Economics Review, 6 (1), 28-72.

Raimi, R. (1985). The first digit phenomenon again. Proceedings of the American Philosophical Society 129, pp. 211-219.

Scopino, G. (2016). Expanding the Reach of the Commodity Exchange Act's Antitrust Considerations. *Hofstra L. Rev.*, *45*, 573.

USDA (2020), "Soybean-to-corn price ratio signals increasing soybean profitability." Economic Research Service. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=99187

Van Smith, M. (1981). Preventing the Manipulation of Commodity Futures Market" To Deliver or Not to Deliver, Hastings Law Journal, 32(6), pp 1569-1607.