The effect of high frequency trading firms and market makers such as Citadel LLC on market efficiency by enhancing liquidity.

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Sample Table of Contents

List of Figures

Page

ABSTRACT

Citadel LLC is an American global financial institution. The company operates as two primary businesses, the first being Citadel, one of the world's largest alternative asset managers, and Citadel Securities, one of the leading market makers in the world, attributing to the trading of equities, equity options, and interest rate swaps for retail and institutional clients. Citadel Technology, which was established in 2009, is also an affiliate of Citadel, and it offers investment management technology to a range of firms and funds. As a market maker, Citadel plays a vital role in the stock market. They are responsible for executing the trades between the buyer and seller. With the advancement of technology and the demand for speed, Citadel has transformed trade execution from the shouting and paper-flying pits on the trading floor of the New York Stock Exchange, to a highly automated information system, capable of executing hundreds of thousands of orders every second. They were able to do so by incorporating high powered information systems, that use algorithms in two primary functions. The first function is to maintain the firm's profitability by executing orders between buyers and sellers with lightning speed. The second function, though it tends to be more of a positive effect of the first function, is to add liquidity to the market. High liquidity increases market efficiency, which benefits all participants. There are ethical drawbacks to such practices, such as a notion that these firms have an unfair buy and sell price advantage over retail investors using a strategy called front running. However, the cost to use said strategy is incredibly high.

INTRODUCTION

One of the most common indications of an efficient market is its liquidity (the capability to provide both buyers and sellers the ability to trade assets without drastic price changes). As a general rule, the more participants there are in the market, the higher the liquidity will be. This is due to an economic principle where all buyers and sellers want the best possible price, and when there are more choices available, a price equilibrium will appear. Liquidity is extremely important in the stock market, because large price swings can create panic, which has quite an adverse effect on market trends. Though markets become more efficient with more participants involved, the task of fulfilling all of their orders becomes increasingly difficult. A need for information technology becomes evident, as it is beyond the scope of human abilities to manage the vast amounts of information involved with modern securities exchanges. Citadel was one of the first institutions to recognize the need for advanced information technology in the securities exchanges. The finance industry is very data driven, and there is a heavy reliance on quick, reliable information in order to make sound investment decisions. By using groundbreaking information systems, Citadel and other market makers were able to provide the markets with liquidity and a net benefit to exchanges all around the world.

Research Problem:

Liquidity within securities exchanges is of the utmost importance because it allows for a smooth trade of assets amongst its participants. Liquidity is generally increased by having more participants in the exchange; however, it can be manipulated by high frequency trading firms and market makers such as Citadel. Their complex algorithms and immense data processing capabilities allow them to provide liquidity in the market by completing millions of trades a second, through various different trading techniques and strategies. According to the *Wall Street Journal*, about one-third of stock orders from individual investors is completed through Citadel, which accounts for about 10% of the firm's revenue. (Copeland, 2015)

In addition to providing the market with liquidity and volume, Citadel collects, stores, and distributes thousands of data points on every single security on the exchange and other market participants are able to use this information to make their own investment decisions. Citadel, along with other market makers are keystone components of a modern market, and their effect on global exchanges is substantial.

Research Goal:

To explore how high frequency trading firms and market makers such as Citadel use information system technologies to create a competitive advantage, in addition to increasing liquidity and efficiency to modern securities exchanges; as well as explore the possible ethical issues that these firms pose.

Relevance and significance:

An individual who has a vested interest in the stock market, and other securities exchanges must understand HFT firms and market makers' role in the market, and how they

operate. These firms are incredibly powerful and have tremendous influence over the market. They have an inherent price advantage in terms of purchasing and selling securities that a retail investor must be wary of. It would be foolish for a retail investor to model their investment strategy off of a HFT firm's, because it is nearly impossible for one individual to have enough capital to have access to the technology of these firms. Citadel is the gold standard for high frequency trading, and competing firms must learn and adapt in order to survive. Citadel's group of hedge funds rank among the largest and most successful hedge funds in the world. The hedge fund's assets under management has increased by 29% and more than $10 billion since 2014. (Copeland, 2015) The benefits to the market that Citadel provides are vast, and they have become one of the leading market makers in the world. However, as a pioneer in such a niche industry, there is less legal oversight than there otherwise would be in a more established industry. It is important for regulating bodies to be aware of how Citadel operates, and maintain fair and legal trade on their exchanges.

Definition of Terms

High Frequency Trading (HFT): a method of trading that uses powerful computer programs to transact a large number of orders in fractions of a second. It uses complex algorithms to analyze multiple markets and execute orders based on market conditions.

Market liquidity: a market's feature whereby an individual or firm can quickly purchase or sell an asset without causing a drastic change in the asset's price.

Retail investor: a non-professional investor who buys and sells securities, mutual funds, or exchange traded funds (ETFs) through traditional or online brokerage firms or other types of investment accounts.

Institutional investor: a nonbank person or organization that trades securities in large enough share quantities or dollar amounts that to qualify for preferential treatment and lower commissions.

Slippage: the difference between the expected price of a trade and the price at which the trade is executed. It can also occur when a large order is executed but there is not enough volume at the chosen price to maintain the current bid/ask spread.

Bid ask spread: the amount by which the ask price exceeds the bid price for an asset in the market. The bid-ask spread is essentially the difference between the highest price that a buyer is willing to pay for an asset and the lowest price that a seller is willing to accept.

Speculation trading: the act of conducting a financial transaction that has substantial risk of losing value but also holds the expectation of a significant gain or other major value.

Market maker: a brokerage house that provides purchase and sale solutions for investors in an effort to keep financial markets liquid.

Options: financial instruments that are derivatives based on the value of underlying securities such as stocks. An options contract offers the buyer the opportunity to buy or sell—depending on the type of contract they hold—the underlying asset.

Volume: the number of shares or contracts traded in a security or an entire market during a given period of time. For every buyer, there is a seller, and each transaction contributes to the count of total volume.

RESEARCH APPROACH

Strengths of the Research

Access to Reference Sources: As a student at the college, access to a large database of journal articles facilitated the core of the research.

Access to Peer-Reviewed Articles:

Finding information through previously research peer reviewed articles allows for a more scholarly research understanding from someone who may have gathered more information that others can find beneficial in helping to find solutions to the research problems.

Weaknesses of the Research

Lack of Real-World Resources:

The research assignment was based on a class requirement which did not allow for actual contact with other potential resources. No interview was conducted. No additional data was accumulated.

Inadequate Search Results:

While there were several sources of reference available in the library databases, due to time constraint, the search results did not provide a wide range of related articles.

Availability of Research Data:

To effectively make a research conclusion, research data is required. No data was gathered for the research.

Limitations of the Research

Budget/Cost:

No budget was available to enhance the research into the information system, thus restraining accessibility to real examples. Also, with the short time constraint, the research was not as expanded as intended to be.

Time Constraint:

The research was not as expanded as intended to due to the limitation of time. To be able to have a proper and in-depth research it would require more time, interview with users, the company's management

Research Skill/Lack of Training:

Since the research conducted was based on guidelines provided in class, the skills needed to conduct a full APA style research was limited. The researcher has not received training in research writing which contributes to the overall structure of the study. The researcher has not been exposed to the vast amount of information that is affiliated with MIS and only learned from lecture.

RESEARCH FINDINGS

High frequency trading firms such as Citadel primarily make their money in fractions of a second by using a Securities Information Processor. The technology is used to collect quote and trade data from different exchanges, collate and consolidate that data, and continuously disseminate real-time price quotes and trades for all stocks. "The SIP calculates the National Best Bid and Offer (NBBO) for all stocks, but because of the sheer volume of data it has to

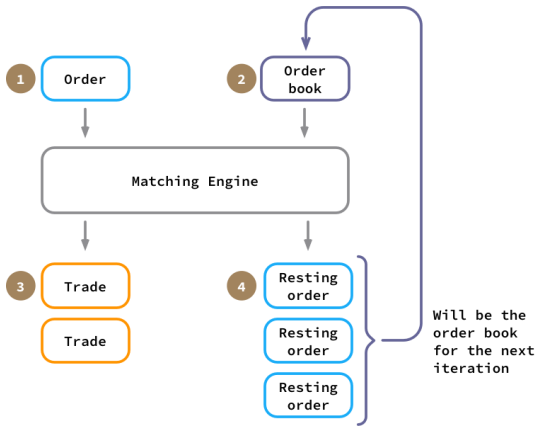
handle, has a finite latency period. However, that latency period can be as much as 25 milliseconds." (Picardo, 2019) They are able to secure the best price both on the buy side of the trade, as well as the sell side of the trade. There are two primary types of orders when it comes to buying and selling securities. There are also two parts to each order: the bid and the ask. The bid is the price at which the market participants want to buy the security. The ask is the price that the market participants want to sell security at. The difference in these two prices is called a spread, and the average of these prices is called the market price. This is typically the price that the security will be displayed at.

The first type of order is a limit order. When using a limit order, the trader selects the price at which they would like to purchase or sell the security. For example, if stock XYZ is currently trading at $12.34, and the trader would like to purchase the stock at $12.33, they will set a limit order at $12.33. The order will not go through until the price of XYZ falls to $12.33. However, the other type of order, a market order, operates quite differently.

When a market participant enters a trade with a market order, the best possible price is not guaranteed, only execution speed is guaranteed. So, to expand on the same example, if stock XYZ is trading at $12.34, that is only the market price. The bid is $12.33, and the ask is $12.35. If a trader wants to buy the stock with a market order, it is likely that the order will go through at $12.35 (the ask price), even though the buyer wanted to purchase the stock at $12.34 (incurring an automatic $.01 loss per share). Citadel is able to profit off of this slippage by executing a controversial strategy called front-running, "which involves a HFT firm racing ahead of a large client order on an exchange, scooping up all the shares offered at various other exchanges (if it is

a buy order) or hitting all the bids (if it is a sell order), and then turning around and selling them to (or buying them from) the client and pocketing the difference." (Picardo, 2019) This a predatory trading practice, that is not illegal, but is considered unethical by some.

High frequency trading firms make their money in fractions of a second by using four primary information system technologies to provide services to their clients, and generate profit within the company. The first technology is called co-location servers. Citadel's servers are located in the exact same place as the exchanges' (NYSE, NASDAQ, etc.) servers. This gives Citadel access to information such as stock price changes milliseconds before other traders. Because information is vital in the finance industry, Co-Location is a very lucrative business for the exchanges, charging firms millions of dollars for that millisecond advantage. The second technology that Citadel uses is low latency hardware. Latency is the time that elapses from the moment a signal is sent to its receipt. The biggest factor in lowering latency is decreasing the distance the signal/information has to travel. These firms usually use fiber optic cables to further improve latency, as they are able to transfer information at the speed of light. The third information technology that market makers use is a matching engine. This software is the heart and soul of a modern stock exchange. It continuously matches buy and sell orders to keep the market flowing smoothly. It is a keystone component to the computer systems of the exchange, so it is vital for Citadel to have their servers located as close as possible to the exchange's servers. The fourth type of technology used is a securities information processor, or commonly called the SIP. The SIP calculates the National Best Bid and Offer (NBBO) for all stocks. It is used to collect price and other various data points on thousands of stocks



from different exchanges, organize and consolidate the data, and distribute real-time price quotes and trades for all stocks. Because of the sheer volume of data it has to handle, there is a finite latency period (generally no more than 25 milliseconds). According to a report in the March 2015 edition of Risk Magazine, Citadel provides quotes to traders in an average time of 0.35 seconds, compared to 2.05 seconds for the next closest market maker. For the Co-Location servers and matching engines, the order execution process has improved significantly. The order is routed to a more favorable exchange and is executed swiftly, thanks to Citadel's Securities Information Processor.

These benefits do not come without cost. The trading done by HFT firms are nearly impossible for a retail investor to understand. Citadel uses complex trading strategies such as front running and pinging which are considered unethical to some. By using algorithms and high-powered computers to operate their Co-Location servers, Citadel has an unfair advantage over retail investors because Citadel has access to vital information faster than retail investors. There is inherent risk in relying primarily on algorithms and computers, and sometimes it backfires. Citadel's complex strategies can sometimes create havoc for the regulators to manage. For example, if a stock price is falling faster than usual, that may trigger the algorithm to begin to dump the stock. Though there may be a logical explanation for the price drop (the entire market is down that day), the algorithm doesn't have a human element to make the decision to sell or hold, it will just do as programed, and continue selling, further lowering the stock price. Though it can be argued that high frequency trading firms and market makers such as Citadel pose a great risk to the stock market, they have become such a large aspect of modern markets that there is no quick solution to control them. Regulators can't simply put a ban on them.

CONCLUSION

In order for businesses to succeed, there must always be a push for data driven decisions, and an implementation of information systems. The stock market has evolved immensely since its early days, thanks to constant technological advances such as powerful computers and data storage facilities. Technology has provided more individuals than ever before the opportunity to invest; the market is not just comprised of large institutional investment firms anymore. With more investors comes more buying and selling; and it is not uncommon for a blue-chip stock (for example, Apple) to see tens of millions of shares traded in a single day. A need for an automated exchange is dire in this sense, as it is virtually impossible for a human to fulfill that many orders. HFT firms and market makers such as Citadel are keystone aspects of modern securities exchanges. "Some industry reports indicate that high-frequency trading firms, or HFTs, account for approximately 50–60% of U.S. equity trading volume." (Rennison, 2018)

HFT's add liquidity and increase trade efficiency within the market by operating on both sides of the trade. They use four primary information system technologies: Co-Location servers, low latency technology, matching engines, and Securities Information Processors. The conjunction of all four allow Citadel to operate at maximum efficiency, and provide value to every market participant. "Citadel Securities automation has resulted in more reliable trading at lower costs and with tighter spreads." (Marek, 2012) "Barron's recently ranked Citadel Securities #1 in providing price improvement for investors in both S&P 500 and non-S&P shares." (Alpert, 2015)

Citadel has adapted well to a more technologically driven market. They have transformed the very nature of the way exchanges operate, by eliminating the need for human brokers executing trades, to an automated process that vastly improves efficiency. From an economic

view point, it is hard to see an ethical problem with what HFT firms are doing. They exploit an inefficiency, which is what every good trading strategy should do one way or another. If there is an ethical conflict, it is safe to lay blame on the exchanges for allowing these firms to co-locate their servers on the same premises, which is essentially favoring co-located clients over others. If regulators were to step in and establish legislation restricting the way Citadel operates, that would pose a bigger risk to the market than the ethical drawbacks of their "unfair advantage."

REFERENCES

Alpert, B. (2015, February 28). Exclusive: Who Makes Money on Your Stock Trades. Retrieved December 9, 2019, from https://www.barrons.com/articles/exclusive-who-makes-money-on-your-stock-trades-1425103695?tesla=y.

Chan-Lau, J. A., Levy, A., Zhang, J., Myint, S., Famery, F., Siddique, A., … Wood, D. (2015, June 23). Citadel shaking up swaps competition. Retrieved December 9, 2019, from https://www.risk.net/derivatives/2398916/citadel-shaking-swaps-competition.

Copeland, R. (2015, August 4). Citadel's Ken Griffin Leaves 2008 Tumble Far Behind. Retrieved December 9, 2019, from https://www.wsj.com/articles/citadels-ken-griffin-leaves-2008-tumble-far-behind-1438655887.

Marek, L. (2012, October 13). Citadel's big move into the markets. Retrieved December 9, 2019, from https://www.chicagobusiness.com/article/20121013/ISSUE01/310139980/citadel-becomes-top-broker-on-nasdaq.

Picardo, E. (2019, December 2). Understanding High-Frequency Trading Terminology. Retrieved December 9, 2019, from https://www.investopedia.com/articles/active-trading/042414/youd-better-know-your-highfrequency-trading-terminology.asp.

Rennison, J. (2018, January 1). How high-frequency trading hit a speed bump. Retrieved December 9, 2019, from https://www.ft.com/content/d81f96ea-d43c-11e7-a303-9060cb1e5f44.