



2021

'The Robinhood Effect' - Digital technology in global financial markets and its effects on investor decision making

Ben Steib
Colby College

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‘The Robinhood Effect’

**Digital technology in global financial markets and its effects on investor
decision making**

By Ben Steib ‘21
Spring 2021

Colby College
Honors Thesis
Science, Technology, and Society Program

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Acknowledgments:

First, I would like to thank my thesis advisor, Professor **Lijing Jiang**, who has guided me on how to write a thesis throughout the entire year. Despite being extremely busy this year, Professor Jiang has always made time for me and had insightful comments and suggestions on my paper. Thank you, Lijing!

Second, I would like to thank my second reader, **Kara Kugelmeyer**, whose class I took my freshman year inspired me to undertake this thesis project. In January 2018, I took her Jan Plan called “Before and After Google,” where we learned about how technology has impacted so many aspects of our life. I wrote my final paper for that class about the impact of technology on the stock market, and since then, the trend of retail investors has only increased, sparking the fire for this thesis. Thank you, Kara, for introducing me to STS and always being a close ally and friend here at Colby.

Massive shout out to **Scott Fine** for all that he has done to help me get interested and exposed to the finance industry and helped me get to where I am today. Scott, thanks for everything. You have been a great mentor, boss, and friend to me. I appreciate the time you took out of your schedule to answer my questions, and I think your input certainly benefited this thesis. On top of that, it was great to catch up as always.

Thank you to **Tom Joyce** for his time as well. It was great to meet Mr. Joyce virtually through my research, and I hope to meet you in person one day. I appreciated you sharing the story of what unfolded at Knight Capital while you were there, and I feel that it added a great example to the impact of technology on the stock market.

A big STS thank you to my friend, former professor, and advisor, **Jim Fleming**. First, I appreciate your offering to read over my thesis and providing your comments. Second, thank you for allowing me to be your research assistant for my senior year. It has been a pleasure working with you and helping plan the celebration of the beginning of your ‘permanent sabbatical’ this year. Lastly, thank you for creating such a fantastic STS program here at Colby. I have found that through STS, I can study the impacts of the technologies that are affecting the world we live in as we speak. I have also found that people are fascinated by the lens through which we study, and it has undoubtedly helped me stand out while searching for jobs.

I hope the STS program reigns on at Colby in your absence. However, I have strong faith in the college and the new leadership to allow students to continue studying this unbelievably relevant field.

I also want to thank **Lisa Noble**, a trusted friend and advisor at Colby, who has helped me through many decisions I have made and helped me get the jobs I want. She also offered to read over my thesis for me, so thank you very much for your help, Lisa!

Thank you to **BCA Research** for providing their report, “The Democratization of Equity Investing.” I reached out to BCA through the ‘contact us’ page on their website, asking to obtain a report I had seen cited. They typically would sell a report like that to investors. BCA kindly provided it to me for free for use on my thesis. Thank you to Andrew Tobin at BCA for sending the report and allowing me to use BCA’s analysis on RobinTracks’ data in this thesis.

Finally, thank you to **my parents** for always telling me to study and do what I’m interested in, which led me to write this thesis.

Abstract:

We are currently experiencing a revolution that is larger, arguably, than the industrial revolution, it's the Internet, also known as the World Wide Web. The Internet has transformed how we live — how we talk, how we work, how we go about our daily business, and how we manage our finances on a global and individual level. In the late 1990s, an investor would search the World Wide Web and, within seconds, find 3,372 web sites with the term "investment," today, the same search for "investment" yields 1,860,000,000 results.¹ Today, as proven with GameStop and other popular 'meme stocks,' social media, powered by the Internet, has a significant impact on the way people invest and interact with the stock market. In this thesis, I explore the impacts of technology on the financial markets and how those technologies have changed how investors make decisions, as opposed to traditional investment styles.

¹ Kessler, A. (2009). *How we got here: A slightly irreverent history of technology and markets*. New York: HarperCollins.; Google Search, April 2021

Definitions:

- **Brokerage** – a middleman or platform that connects buyers and sellers to facilitate a transaction. For example, Robinhood, Fidelity, E*TRADE or Charles Schwab, to name a few.
- **Broker-dealer** – a company that does business by buying and selling securities for its own account or on behalf of its customers (Investopedia)
- **Commission** – fee charged by a brokerage when you buy or sell a stock, ETF, or other type of investment product.
- **DJIA** – the Dow Jones Industrial Average, a major index in the US
- **Equity** – ownership in a firm, minus debts
- **Financial literacy** – possessing a skillset that allows a person to manage their finances in an informed and responsible way.
- **Fintech** – short for financial-technology
- **Hedge fund** – a type of investment manager that ‘hedges’ themselves from market uncertainty, and tries to make a profit in up or down markets.
- **Institutional investor** – a company that invests money collectively for others. For example, a mutual fund, pension fund, sovereign wealth fund, etc....
- **Liquidity** – how easily you can convert your assets into cash, e.g., if you can sell a stock easily or not.
- **Markets** – where buyers and sellers meet to exchange goods, services, or in this case, financial products.
- **Market-maker** – a firm that buys and sells stock to provide liquidity to the market. See Chapters 4 and 5.
- **Mutual fund** – a pool of money that is invested in a variety of stocks, bonds, or other assets by a professional investment team.
- **NASDAQ** – stands for National Association of Securities Dealers Automated Quotation, second major stock exchange in the US behind NYSE.
- **NASDAQ 100** - a stock market index made up of 100 largest companies listed on the NASDAQ.
- **NYSE** – the New York Stock Exchange.
- **Options** – contracts that gives an investor the right to buy or sell an asset at a predetermined price and date (Investopedia).
 - **Put option** – contract that gives the owner the right to sell a stock at a certain price; usually associated with the belief that a stock will go down.
 - **Call option** – contract that gives the owner the right to buy a stock at a certain price; usually associated with the belief that a stock will go up.
- **Retail or individual investor** – any investor that is investing on their own, for their own benefit. The opposite is institutional investors.
- **S&P 500** – a stock market index made up of the 500 large companies listed on US stock exchanges.
- **Security** – refers to any kind of financial asset, usually either equity in a company, or debt.
- **Shorting a stock** – a way of investing so that the investor profits when the stock price depreciates.
- **Spread** – the difference between two prices.
- **Stock** – fractional ownership of a company.

- **Volatility** – the rate at which a stock price fluctuates; higher volatility means the stock price changes often and rapidly

Introduction:

We are currently experiencing a revolution that is larger, arguably, than the industrial revolution. It's the digital world, powered by the Internet which has transformed how we live — how we talk, how we work, how we go about our daily business, and how we manage our finances on a global and individual level. In 1984, just eight percent of US households had a personal computer, the World Wide Web was still five years away, and cell phones were physically enormous.^{2,3} Today, digital and information technologies and the Internet have produced massive technological changes. Examples include smartphones, which provide access to the Internet almost everywhere globally, and a transition of information from analog to digital formats. With these rapid advances in technology, industries and our daily lives have changed to adapt to being interconnected and having all the resources that the Internet can provide, anywhere and at any moment.

One of the industries that has evolved the most due to instant access to information is the financial services sector. Financial services span a broad spectrum, from personal banking to the high-frequency trading of stocks and options, which I will explain in further detail in Chapter 2. The Internet and everything digital has transformed the way people can interact with their finances. Anyone with a computer and an Internet connection can use a bank or brokerages' services without ever having to go to a physical place or interact with a person, from anywhere in the world. Before computers and the Internet, transactions were done on paper or over the telephone and often took weeks to process. For both companies and individuals, the rapid development of computing and networking technologies has made trading and investing faster, more advanced, and more specific. With the Internet and technologies that offered digital services and

² Newburger, Eric. (2000). Home Computers and Internet Use in the United States, August 2000. From <https://www.census.gov/prod/2001pubs/p23-207.pdf>.

³ History of the Web. (n.d.). Retrieved March 5, 2021, from <https://webfoundation.org/about/vision/history-of-the-web/>

formats for past analog and paper process, anyone with access to it can now have information from around the world.

In 1997, an investor would search the World Wide Web and, within seconds, find 3,372 web sites with the term ‘investment.’⁴ Today, the same search yields 1,860,000,000 results.⁵ Despite that, the massive jump in search results for information regarding investments reflects the drastic democratization of finance that has occurred with technology and the Internet.

Today, the Internet and social media allow people to communicate and form formal and informal communities like never before. In January 2021, investors on a Reddit page called r/WallStreetBets were involved in the skyrocketing of share prices in specific companies, known as ‘meme stocks.’ The primary stock was GameStop. The scenario that unfolded proved that social media has a significant impact on the way people invest and interact with the stock market. The Reddit page that garnered all the attention, r/WallStreetBets, is a group with more than 9.8 million ‘degenerates’ as of April 2021. If each of those people had \$1000 in capital to deploy, that would be \$9.8 billion, an amount that certainly can swing markets. I will discuss the entire situation in Chapter 5 in greater detail. In this thesis, I explore how the financial markets have changed with technologies over time, and how the technology has allowed more and more investors enter the market. Now, anyone can trade stock and become an investor with zero upfront cost. That was not the case even 10 years ago.

As I thought about sources for my thesis, I wanted to speak to people that had experienced the changes that have occurred in the stock market with technology, and how that changed how they trade.

Interview with Scott Fine, hedge fund manager

I had the chance to talk to Scott Fine, a fund manager for over 30 years, who has experienced the changes in the stock market and how investing is done throughout his career. We spoke in late March 2021

⁴ U.S. Securities and Exchange Commission: Report to the Congress: The Impact of Recent Technological Advances on the Securities Markets. (1997, November 26). Retrieved from <https://www.sec.gov/news/studies/techrp97.htm#intr>. Section C-1

⁵ Google.com search, April 2021.

by phone. He shared stories of how he has seen technology change how he does business and the effects of those changes. Throughout my thesis, I will include parts of his story and share with you what he has experienced firsthand.

While studying psychology at Harvard from 1988 to 1992, Scott became fascinated with the many conversations about new technology in Cambridge, Massachusetts at the time. With MIT just around the corner, cutting-edge technologies were being discussed and created all over Cambridge, and Scott wanted to find a way to invest in these new tech companies that would change the world. He was always good at math, so after graduating in 1992, he began working as an equity research analyst at Alta Partners and Gruss Partners, hedge funds where he covered the technology sector. As an analyst, Scott learned how to analyze and model companies, building on his skillset as an investor. After a couple of years, he decided that he could do what his bosses were doing himself, and in 1995 started his own fund, OSO Partners. He started small, but within a year, had done very well and decided he should expand.

After many long nights talking with his apartment roommate Peter Richards about tech stocks, they both decided to start a hedge fund that would invest in what they were always talking about. In 1996, Scott and Peter founded Empire Capital Management, a long/short fundamental driven hedge fund focusing on technology stocks. At the time, the technology sector was booming. The two of them developed a strategy of finding a blend of growth and value stocks to invest in, and made a lot of money for their investors. They were a billion-dollar fund at the peak. After a successful run, the duo decided to close Empire Capital in 2012 and part ways. After several years of investing on his own, Scott began again and launched 19 Capital Management in 2016, another long/short tech and media-focused hedge fund. I was fortunate to intern for Scott and his team for the summer after my senior year in high school and after freshman year at Colby. This gave me the chance to experience how a hedge fund operates and gain valuable life skills. He has been investing in tech stocks ever since, notably taking advantage of the rise in tech stocks in 2020, and he plans to continue for the time being.

Interview with Tom Joyce, former CEO of Knight Capital Group

I also had the opportunity to interview Tom Joyce, the former CEO of Knight Capital Group. Knight Capital, a once-successful market maker, experienced a trading glitch on August 1st, 2012 that led to a \$450m loss that day and negatively affected the market. While researching technological glitches in the stock market and their consequences, I came across what happened with Knight. When I discovered that Mr. Joyce lives near me, I went out on a limb and messaged him on LinkedIn. He kindly agreed to speak with me, and we spoke in late April 2021 over Zoom. I will discuss more of the Knight Capital story in Chapter 7 when I delve into the risks associated with trading electronically.

Before becoming CEO of Knight Capital in 2002, Mr. Joyce was a career retail stockbroker, trading equities at Bernstein and Merrill Lynch. He joined the company when Knight was operating a “hybrid” business model of automated and manual trading, skewed towards manual. Joyce spearheaded the push towards automation, eventually letting go of hundreds of traders and replacing them with quantitative analysts (quants) to make money more reliably by using algorithms to trade instead of people. On August 1st, 2012, Joyce was at home recovering from a knee operation when his head of trading called him and told him about a glitch in one of their systems that had caused a trading loss of around \$450 million in 45 minutes. He went straight to the office and for days worked to keep Knight alive after the loss, which he did successfully.

Chapter 1: The origin of the stock markets and how they worked.

While today the stock market is very large, technologically advanced, and influences many aspects of life, the stock market itself had very simple beginnings. One example, the Dutch East India Company was the first publicly traded company globally, going public in 1602 in Amsterdam. It was the only stock in a company people could buy freely for a long time. It allowed “all the residents of these lands,” in this case Amsterdam, to “buy shares in th[e] company.”⁶ Those who chose to invest in the world’s first public offering could also decide for themselves how much to invest: there was no minimum or maximum. With the first public company trading, others took interest and followed suit. In 1611, the first stock exchange was created in Amsterdam. It is known today as the Amsterdam Stock Exchange, or Euronext Amsterdam.⁷

America began its first stock market after the founding of the nation in the late 18th century. When the government sold \$80 million in bonds in 1790 to pay for the revolutionary war, a market was created to trade those bonds.⁸ Twenty-four merchants began meeting every day under a buttonwood tree in Manhattan to buy and sell stocks and bonds, which became the origin of what we know today as the New York Stock Exchange (NYSE). A building at 68 Wall Street has since replaced that buttonwood tree.⁹

At the time, a stock exchange could not be more extensive than the distance a person’s voice could carry, so it was very small, and only a handful of people could actively participate.

The new market was also providing



Figure 1: Signing of the Buttonwood Agreement in 1792, <https://time.com/4777959/buttonwood-agreement-stock-exchange/>

⁶ Petram, L. (2020, November 25). The world's first IPO. Retrieved from <https://www.worldsfirststockexchange.com/2020/10/15/the-worlds-first-ipo/>.

⁷ Euronext Amsterdam. (n.d.). Retrieved from <https://www.euronext.com/en/markets/amsterdam>.

⁸ Knox, M., & Murray, W. (2015). The dynamics of military revolution, 1300-2050. 87.

⁹ Stoll, H. R. (2006). Electronic Trading in Stock Markets. *Journal of Economic Perspectives*, 20(1), 153-174. doi:10.1257/089533006776526067

liquidity to assets that had traditionally been harder to buy or sell. A quote from Andy Kessler's *How We Got Here* describes how the stock market changed how investments could be bought and sold more efficiently with a growing market.

By providing liquidity for government debt, banks, and soon industrial businesses, the stock market was providing a great service to the US economy. Money was no longer “stuck” in fixed asset investments. By selling stock to someone else, say a bank that wanted to own a portfolio of factories, capital could be freed for investments in new, riskier businesses, with potentially higher returns. This is a stock market at its best, where capital moves around according to the risk profile of each participant.¹⁰

In the 1800s, as the equity market was beginning to gain popularity, most investments were in bonds, not stocks. Almost all the equity market returns at the time were in the form of dividends and not significant capital gains. There was essentially no difference in the return an investor could get from stocks and bonds. That is quite different from today, where stocks can provide a much greater return on investment in a shorter time horizon, as well as the risk of losing more significant amounts of money too.¹¹ It was also much harder to access reliable information on the stock market back then, which has historically been more volatile than the bond market. Making decisions with inaccurate information is a challenging task. Most investors did not have up-to-date information on stocks, which often led them to have to trade with out-of-date data, an aspect of trading that has drastically changed with new communication technologies.

Early access to information

One of the most crucial aspects of the stock market and one that has changed the most over time is access to information. Communication and information technologies are the only way to distribute the

¹⁰ Kessler, A. (2009). *How we got here: A slightly irreverent history of technology and markets*. New York: HarperCollins, Page 200.

¹¹ Taylor, B. (2020, November 17). GFD Guide to Total Returns. Retrieved from <https://globalfinancialdata.com/gfd-guide-to-total-returns>.

masses of data needed to analyze companies, stocks, and the overall market. As communication technology has developed, more people have been able to do more with the available data.

Before the Internet, telephone, or telegraph, people had to find alternatives to get information out and receive it. The origins of mass communication essentially began with the printing press, which was early as 1439. The printing press allowed anyone with a need to share and distribute information to the masses to do so. At first, it revolutionized how information was distributed by allowing newspapers and other resources to be shared with more people.¹²

While the printing press in simpler forms was seen in China as early as the 11th century, the credit for inventing the modern printing press goes to Johannes Gutenberg, a German inventor, and publisher. Gutenberg invented a machine that allowed for the mass production of books for the first time in history. Before his invention, books were transcribed by hand or 'printed' using wooden blocks. Both techniques were painstakingly slow and laborious. That meant access to the printed word was limited to those who could afford their high price tags. The printing press made information, on paper at the time, more affordable and available, therefore democratizing knowledge. Simultaneously, when books became more available (primarily the Bible at first), there were also religious and political shifts like the Reformation, which shifted the power of knowledge from an elite minority to every man. While that did not happen instantly, people became more literate and educated over time because of better access to information provided by the printing press.

Another benefit of print is that it made knowledge more standard and accurate. Human scribes are naturally prone to error, but errors, while possible in mass printing too, could be resolved with standardizing printing. Just as writing had freed knowledge from individual human memory limits, print freed information from the constraints of hand-copied texts. The mass production of information led to a radical increase in knowledge in the Western world. The new availability of information led to new advances in scientific and other studies. Knowledge could be more easily obtained and far more easily disseminated, which led to

¹² Odriscoll, S., & Eisenstein, E. L. (1985). The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe. *Leonardo*, 18(2), 122. doi:10.2307/1577894

spectacular increases in new knowledge creation, as scholars built on shared information and collaborated in study. Abstract thinking and deductive reasoning became the norm increasingly, and the humanities and sciences flourished. Therefore, one can arguably say that the invention of the printing press is one of the most fundamental tools that shaped our world. It facilitated the Scientific Revolution, for example, on whose foundation came the Industrial Age, and eventually the Age of Information which we live in today. Despite the innovation that the printing press provided, it was not used for stock price information until the late 19th century.

Information for trade

In April 1850, Julius Reuter started a news and stock price information service using carrier pigeons between Brussels, Belgium, and Aachen, Germany, using 45 trained birds. There was no telegraph line for the 76 miles between Brussels and Aachen, and the alternatives were messages by rail, horseback, and word of mouth. Birds were sent each day by rail to Brussels and then flew back to Aachen with the information, saving time and giving the person requesting it an advantage over competitors who did not use Reuters' service. Their flight only took two hours, which was much quicker than by rail, and it worked! That service became the major news outlet Reuters that we know today and was one of the earliest technology providers to the markets. Reuters continued sending time-sensitive information by carrier pigeon until a telegraph line was built in the first quarter of 1851.

The electric telegraph was a game-changer in communication technology. Invented in the 1830s, it allowed messages to be sent much faster than the system in place, mainly messengers riding on horseback. This form of communication worked by transmitting electrical signals over the wire. To send messages and understand them, Samuel Morse created the Morse Code. This system assigned a set of dots and dashes to each letter of the English alphabet and made it possible to send complex messages over the wire. The telegraph quickly took off, with people eager for a faster and easier way of sending and receiving messages and information. The only drawback to the telegraph was that it required a unified station system regionally, nationally, and worldwide, which was eventually built out but took decades. The Western Union Telegraph

Company was only one of many such companies that developed around the new medium during the 1850s.¹³ By 1861, however, Western Union had laid the first transcontinental telegraph line, making it the first nationwide telegraph company.¹⁴ The electric telegraph transformed how information was communicated, which changed how wars were fought and how news spread. Rather than taking hours, days, or even weeks to be delivered by horse and carriage, the news could be exchanged between telegraph stations almost instantly. The telegraph also had a profound economic effect, allowing money to be “wired” across great distances. At the time, some statistics suggest that over half of the telegraph line capacity were trades in stocks and bonds, showing the strong demand for rapid trading.¹⁵ Rapid communication served as the foundation for global economic expansion in the 19th century and allowed humanity to thrive.

By the mid-1870s, the telegraph had become the “nervous system of commerce,” according to Western Union President William Orton.¹⁶ Western Union’s near-monopoly on the telegraph in the US spurred inventors to experiment and, in some cases, create competition. Inventor Alexander Graham Bell wanted to improve the capacity of telegraph lines’ to send speech by wire. Bell, a teacher of the deaf, drew on his studies of sound and speech to devise a method of transmitting voices over electrical wires. Unlike the telegraph, the telephone enabled people to communicate directly, without special skills or codes. Working with electrician Thomas Watson, the duo was the first to develop and patent a telephone in 1876. President Rutherford B. Hayes said to Bell at the time, “That’s an amazing invention, but who would ever want to use one of them?” The only issue was that their invention was primitive, and there was no network—instead, the phones were connected by cable from two fixed places. There needed to be an infrastructure in place to make a telephone system practical and valuable.

¹³ Western Union Corporation. (2015, January 22). Retrieved from <https://www.britannica.com/topic/Western-Union-Corporation>.

¹⁴ History.com Editors. (2009, November 09). Morse Code & the Telegraph. Retrieved from <https://www.history.com/topics/inventions/telegraph>.

¹⁵ Kessler, A. (2009). *How we got here: A slightly irreverent history of technology and markets*. New York: HarperCollins, page 200.

¹⁶ Mr. Watson - Come Here - I Want to See You. (2011, July 20). Retrieved from <https://www.rte.ie/radio1/doconone/2011/0720/646837-radio-documentary-alexander-bell-telephone-patent-watson-i-want-to-see-you/>.

The Bell Telephone Company was founded in 1877 and immediately began construction on the first telephone lines, switchboard, and telephone exchange. Bell merged with other companies in 1885 and became American Telegraph and Telephone Company (AT&T), which dominated telephone communications in the US for the next century. Telephone lines were constructed across the nation, allowing people to be reached wherever they were. The network continued to expand rapidly over time, and by 1905 there were 2.2 million phones in the US.¹⁷ In the early 20th century, the telephone was becoming a staple in American homes and quickly gained popularity across Europe, but at a slower rate.¹⁸ By 1956, AT&T had opened the first trans-Atlantic telephone cable for service, which connected North America and Europe. The line's initial capacity was 36 calls at a time at a price per call of \$12 for the first three minutes (\$117 today). Over time and as competition expanded, the price for calling dropped, fueling communication and global growth. People embraced the ability to talk to anyone with a phone from a distance, and it allowed information to be exchanged and stories to be shared, further expanding the power of a single person in one place.

While it was possible for those in areas that supported it to use these new technologies, per minute or message use still came at a high cost because of the high demand for using the new, low-capacity telegraph and telephone lines. Most people would only have made a call when they needed to or if they were wealthy enough to afford the cost of calling a broker. That meant that only certain people who were willing to pay would be able to access stock market information that was up to date. The device that those who could afford it was called a 'stock ticker,' which has evolved with technological capabilities. For everyone else, beginning in 1884, the Dow Jones began publishing end-of-day stock quotes in a newsletter that became the Wall Street Journal. Figure 2 is a page from one of the first Wall Street Journal editions.

¹⁷ Millward, R. (2005). Railways and telegraph: Economic growth and national unification. *Private and Public Enterprise in Europe*, 2nd ser., 59-75. doi:10.1017/cbo9780511497124.006

¹⁸ The development of telecommunications. (2005). *Private and Public Enterprise in Europe*, 2nd ser., 99-110. doi:10.1017/cbo9780511497124.009

to process massive transactions and then profit from the spread between the market and what a client will pay. As Kessler said in *How We Got Here*, “Wall Street and technology are as inseparable as Bonnie and Clyde.”¹⁹

Chapter 2: Going digital

The invention of the Internet

The early history of computers is about computing numbers. In 1833, Charles Babbage, the “father of computing,” created the first mechanical device to compute numbers, known as the “difference engine.”²⁰ While his invention never came to fruition, it sparked the beginning of creating devices to help humans process immense amounts of information. The first actual commercial use of an early “computer” was during the 1890 census by the US Government. The computer processed punch cards, which census data was recorded on, and then added the results to output a final figure. It was created by Herman Hollerith, who would go on to form International Business Machines (IBM) in 1924.

As I mentioned earlier, stock market trades throughout the 20th century were generally done by brokers over the phone or in person, mainly with paper records. The business was conducted on the floor of a stock exchange like the New York Stock Exchange (NYSE). Brokers of a particular type of security would gather and use open outcry, a system where they announce what price and quantity of shares they are selling. For example, people buying equities (stocks) would congregate together, as would those trying to trade bonds. Buyers could then negotiate with the trader verbally, and if a deal were reached, they wrote it down on a ‘deal sheet.’ At the end of each trading day, traders would check their book of trades to ensure all transactions were accurate on their counterpart’s book as well.²¹ In 1918, a system using pneumatic tubes was developed to send and receive stock quotes and send information around a stock exchange to replace

¹⁹ Kessler, p.202

²⁰ The Babbage Engine. (n.d.). Retrieved from <https://www.computerhistory.org/babbage/>.

²¹ Gordon Scott, C. (2020, August 25). Open Outcry Definition. Retrieved from <https://www.investopedia.com/terms/o/openoutcry.asp>.

the often-inaccurate paper system.²² The system was first installed in the NYSE in 1922. Capsules carrying orders and reports of stock sales traveled through the pneumatic tube system from the broker's booth to the trading post and to the Ticker Department.²³ This system worked well but was only for short distances and was not instant. It was quick and accurate but not instant.

Much of the process of getting quotes and trading stock in the mid-20th century was manual, and despite some improvements from the telegraph and telephone, it still took a significant amount of time to trade a stock or bond. In 1949, punch cards were introduced to record trades and then were sorted by automated tabulators. In 1950, electronic computers started doing the sorting. In 1961, magnetic tape stored data, and in 1964, computers were used to clear specific trades by matching records. Once the computer was introduced, stock markets quickly phased out the pneumatic tube system in favor of electronic messaging. The technology that emerged from World War 2 was indispensable to Wall Street. These computers allowed for more stock trading to happen, volume increased, and since commissions were fixed, profits went straight up for the middlemen.²⁴ Wall Street was a money-making machine with all the trading going on.

In 1967 and 1968, market volume increased 30% a year, both years, causing issues with the strenuous back-office clearing process associated with trading stocks pre-computer. Brokerage firms were struggling with the amount of trading volume, and in some cases, had stock certificates piled up to the ceiling. Even hiring more people did not help, and customers stopped paying for the stocks they bought because they were not receiving the certificates. The NYSE began closing one day per week to allow brokerages to catch up with the paperwork.²⁵ As a result, a central certificate service was created that took advantage of new technology to create an electronic certificate, avoiding needless bookkeeping. Despite

²² Tebo, J. D., & Keive, J. L. (1974). The Electric Telegraph: A Social and Economic History. *Technology and Culture*, 15(2), 332. doi:10.2307/3102931

²³ Roche, J. L. (2013, April 23). Here's How Traders Used to Instant Message Each Other Back In 1922. Retrieved from <https://www.businessinsider.com/pneumatic-tubing-system-used-for-trading-2013-4>.

²⁴ Kessler, A. (2009). *How we got here: A slightly irreverent history of technology and markets*. New York: HarperCollins, page 225

²⁵ *History of NYSE Holidays and Special Closing Days, 1885-present* (Rep.). (2011, January). Retrieved <http://s3.amazonaws.com/armstrongeconomics-wp/2013/07/NYSE-Closings.pdf>.

the changes, it was too late for some 160 NYSE member firms who had their credit squeezed due to the gap in the paperwork and went bankrupt.²⁶

As computing power increased, more and more applications were found for them, and as a result, computers became more commonplace in trading firms as they were available. In the 1980s and 1990s, there were massive strides in computer hardware technology, such as the IBM PC in 1981, that made them smaller and cheaper, allowing more people to access them. At the same time, those with money, meaning hedge funds and large institutional investors, could use computers to their advantage and analyze stocks in a way that had never been done before. “Quantitative, or “quant,” funds use computer models to screen stocks based on predetermined criteria such as earnings momentum, price/earnings ratios, and relative price. With these funds, the computer generates most, and in some instances all, of the investment decisions.”²⁷ The introduction of science, math, and computing into finance and the stock market allowed everything to be done faster. Computers could also analyze and compute more accurately, changing a previously speculative and uncertain market into one that could be potentially understood, predicted, and controlled using new technologies and strategies.

With all these technologies available, in 1971, the world’s first electronic stock market was founded. NASDAQ, or the National Association of Securities Dealers Automated Quotations.²⁸ Up until the NASDAQ, trading was done by phone. The NASDAQ provided up-to-date price quotes nationwide through a computer system, allowing people to access information that was more accurate and up to date than ever before. Shortly after its launch, NASDAQ built a fully electronic stock exchange from the ground-up, a drastic evolution from what a stock exchange had been. The first company listed on the NASDAQ stock exchange was Intel in 1971, and it began a longstanding partnership between the NASDAQ and

²⁶ Kessler, A. (2009). How we got here: A slightly irreverent history of technology and markets. New York: HarperCollins, page 226

²⁷ U.S. Securities and Exchange Commission: Report to the Congress: The Impact of Recent Technological Advances on the Securities Markets. (1997, November 26). Retrieved from <https://www.sec.gov/news/studies/techrp97.htm#intr>, Section 3a.

²⁸ Friedman, A. T. (n.d.). About Nasdaq. Retrieved from <https://www.nasdaq.com/about>, history section.

technology. They offered 350,000 shares at \$23.50/share.²⁹ Other tech companies like Apple, Microsoft, and Google all went public in the years after on NASDAQ, further cementing its relationship with Silicon Valley. The relationships NASDAQ had with these tech companies also allowed them to benefit from the technologies they were implementing first, such as chips from Intel that helped computing power which in turn helped execute trades faster and more reliably.

Despite the advancements in technology, for most investors, trades were still made over the phone, which was the norm up until the late 1990s. With the Internet, companies like E-Trade were seriously disrupting how people traded stock up until that point. In my interview with Scott Fine (see intro for bio), he shared the process of how he bought his first stock when he was a sophomore in college in 1990. At the time, he was likely one of a few college kids with a brokerage account, and most people only had investment accounts for retirement. He wanted to buy a bank stock, so he called his brokerage and let them know precisely what he wanted to buy or sell and how many shares. After hanging up, the trader would execute the order, and then Scott would wait for them to call him back with the trade confirmation. The process back then was a slow and tedious one that would be difficult to do quickly. On top of that, he was paying a sizeable commission to do so, which is generally not the case today.

Expansion of the Internet

The invention of the personal computer and the Internet completely revolutionized how financial services companies operated, from being mainly paper-oriented to run digitally. In 1982, the first Bloomberg terminal was installed at Merrill Lynch, an investment bank. It allowed traders to monitor real-time market data and allowed trades to be placed on an electronic financial system, making the open outcry system a thing of the past. The same year, E-Trade was founded, allowing individual investors to execute trades over the Internet.³⁰ The Internet revolutionized the way that the public can interact with financial

²⁹ Ibid, Intel section

³⁰ E*TRADE Financial Corporation. (n.d.). Retrieved from <http://www.fundinguniverse.com/company-histories/e-trade-financial-corporation-history/>.

services. Data on companies and their financial outlook and public offering have become much more available, allowing anyone to trade in the markets actively. Compared to the manual, paper-based system, trading via computers proved to be much less expensive, in large part because the time to conduct trades has been significantly reduced. As an additional benefit, companies have seen a reduction in the operational risks of fraud and manipulation.

Once computers and information technologies became more commonplace, there was a demand to share more information, like documents or research or stock price information. The history of the Internet originates in building and interconnecting computer networks that arose from military and scientific research and development in the United States and involved international collaboration, particularly with researchers in the United Kingdom and France.³¹ It started in the 1960s when MIT computer scientist J.C.R. Lickliter came up with a global computer network. The Internet continued developing and expanding, initially only allowing email and document transfers from mainframe to mainframe, restricting it to major institutions or government.

In 1990, Tim Berners-Lee and his colleagues at CERN in Geneva developed hypertext markup language (HTML) and the uniform resource locator (URL), forming the bedrock for the World Wide Web.³² In 1995, Microsoft launched Windows 95 with Internet Explorer, and Amazon, Yahoo, and eBay were all launched. In 1996, Congress passed the Communications Decency Act to combat the growing amount of indecent material on the Internet, and Google was founded in 1998.

At the same time, during the late 1990s, businesses benefited from efficiencies provided by the Internet and computing as computer hardware became more commonplace and less expensive. The ability to coordinate design, manufacturing, distribution and sales through computer systems and the Internet changed the game for many companies and made them much more profitable. As the Internet was expanding, global communication and trading exploded in popularity as well. With the Internet, anyone

³¹ Leiner, B. M., Cerf, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D. C., . . . Wolff, S. (2009). A brief history of the Internet. *ACM SIGCOMM Computer Communication Review*, 39(5), 22-31. doi:10.1145/1629607.1629613

³² Tim Berners-Lee. Accessed May 9, 2020. <https://www.w3.org/People/Berners-Lee/>.

could access investments, generate new ideas, and become an investor. Prices, forecasts, currency rates, were now available in real time to anyone with an Internet connection. Sending a telegraph and then receiving one back was a thing of the past, or even worse, reading market news a day late in the Wall Street Journal. The popularity of online trading took off because of accessible information, the simplicity of electronic trading, and low fixed costs to process a trade.³³ Demonstrating the growth and popularity of online trading, E-Trade's revenues went from \$15 million in 1992 to \$142.7 million in 1996 and was rated as the fastest-growing company in America that year.³⁴ Since then, hundreds of online brokerage firms have entered the market, increasing competition. Customers can now choose from a multitude of different online brokerage services, such as TD Ameritrade, E-Trade, Fidelity, and Robinhood, and each of these services is easily accessible 24/7 via the Internet. The Internet also transformed personal banking by enabling anyone with a computer and an Internet connection to use a bank's services without ever having to go to a bank or trade stock from anywhere globally.

The transformation was not instant, however. For many years, access to the Internet was a costly luxury and was only accessible to those who lived in areas that could get it. According to Pew Research, in 1990, 42% of US adults said they use a computer, but only 1% had access to the Internet. In 2014, eight in ten US adults (81%) said they use computers, and 65% of them had Internet access.³⁵ The massive expansion of the Internet gave hundreds of millions of people access to the financial markets, whether they knew it or not. Historically, the vast majority of stock market trading has been done by institutional firms and very wealthy investors, who benefited the most initially from the speed given by computers and the Internet. Before 2007, most trades went through a person in some form, meaning that trade speed was limited by the human putting the trade-in. After 2007, the exchanges had transformed to being data centers

³³ Diaz-Rainey, I., Ibikunle, G., & Mention, A. L. (2015). The technological transformation of capital markets. *Technological Forecasting and Social Change*, 99, 277–284. Page 4.
<https://doi.org/10.1016/j.techfore.2015.08.006>

³⁴ E-Trade 10-K Filing, 1998

³⁵ Fox, S., & Rainie, L. (2019, December 31). Part 1: How the Internet has woven itself into American life. Retrieved from <https://www.pewresearch.org/Internet/2014/02/27/part-1-how-the-Internet-has-woven-itself-into-american-life/>.

of servers, and the speed at which a trade could be executed was no longer limited by human capacity.³⁶ The capacity was now limited by the maximum capacity of the servers, computers, and infrastructure. Those with the fastest Internet would have a competitive advantage and attempt to eke out a profit with the time saved, consistent with what counted as an advantage previously.

High-Frequency Trading

Individuals' ability to readily buy and sell shares via the Internet led to the creation and application of High-Frequency Trading (HFT). HFT is a way of trading securities using a quantitative algorithm that processes data and trades based on that information at a very high speed. The rapid-fire trading style became popular when exchanges like the NYSE began offering incentives for companies to add liquidity to the market. For instance, the NYSE has liquidity providers called Supplemental Liquidity Providers (SLPs) that add competition and liquidity for existing quotes on the exchange, essentially fulfilling orders. The SLP was introduced after the collapse of Lehman Brothers in 2008 to ensure constant liquidity in the market. As an incentive to companies, the stock exchange pays the SLP a rebate for providing the liquidity. As of March 2021, the rebate for NYSE listed securities was \$0.0012/share.³⁷ The SLPs usually offload the stock immediately, another aspect made possible because of high-frequency electronic trading, and many market participants do similar things. By doing this many times a day, an SLP can make a large amount of money by simply buying and selling shares automatically by using a computer algorithm.

Automated buying and selling in the market have also helped ordinary investors by making costs more standard. Bid-ask spreads are the difference between what buyers want to pay and what sellers want to be paid. Those spreads have dramatically fallen over the past 20 years. One reason for the thinning spreads is because, in 2001, stock prices went from trading in fractions to pennies, allowing prices to be

³⁶ Lewis, M. (2015). Flash boys: Cracking the money code, page 9.

³⁷ New York Stock Exchange, Price List 2021, accessed on https://www.nyse.com/publicdocs/nyse/markets/nyse/NYSE_Price_List.pdf.

more precise, leaving less room for negotiation.³⁸ The lower spreads are generally better for everyone in the market because of better pricing and less risk of an investor being taken advantage of, or receiving a bad price for a trade. Traders who used to make an absolute fortune could no longer do so because the market was becoming more transparent.

Despite the many benefits of high-frequency trading, not all the effects are positive, and the practice has been met with harsh criticism. The concept of using mathematical models and algorithms to make decisions takes the human completely out of the equation, undermining people making trading decisions. General concerns arise around the lack of human interaction with an algorithm responsible for massive amounts of trading. Trading decisions happen in fractions of a second and could result in significant market swings without any apparent reason other than an algorithm's decisions. In September 2009, the Securities and Exchange Commission (SEC) proposed banning 'flash orders' entirely. The SEC's primary concern with HFT was that it could create a 'two market system,' which would favor computer systems over regular investors. The proposal to ban HFT never went into effect because of disagreements over having a free, open market, despite concerns of that kind of trading putting regular investors at a disadvantage.³⁹

HFT has been used as a trading technique since 1999 but gained the market's attention on May 6th, 2010, when the Dow Jones Industrial Average dropped the most it ever has in a day, down 1,000 points and dropping 10% in less than 20 minutes before rising again, closing even on the day. The 'flash crash,' as it is known, raised concerns about how markets can react rapidly because of trades being processed so quickly.⁴⁰ A Securities and Exchange Commission investigation into the event blamed a massive stock order by an algorithmic trading platform that triggered a sell-off for the crash.⁴¹ That sell-off proved to

³⁸ Aitken, M. J., Frino, A., Hill, A. M., & Jarnecic, E. (2004). The impact of electronic trading on bid-ask spreads: Evidence from futures markets in Hong Kong, London, and Sydney. *Journal of Futures Markets*, 24(7), 675-696. doi:10.1002/fut.20106

³⁹ Banning Marketable Flash Orders Open Meeting of the Securities and Exchange Commission. (2009, September 17). Retrieved from <https://www.sec.gov/news/press/2009/2009-201-factsheet.htm>.

⁴⁰ Diaz-Rainey, I., Ibikunle, G., & Mention, A. L. (2015). The technological transformation of capital markets. *Technological Forecasting and Social Change*, 99, 277-284. <https://doi.org/10.1016/j.techfore.2015.08.006>

⁴¹ Testimony Concerning the Severe Market Disruption on May 6, 2010. (2010, May 11). Retrieved from <https://www.sec.gov/news/testimony/2010/ts051110mls.htm>.

everyone the power of algorithmic trading and how it can affect the whole market. In 2014, it was estimated that HFT did between 24% and 43% of all trading in the European equity markets.⁴² HFT is still active today, and as technology has become more accessible, more people can mimic the trading patterns of high-frequency traders. HFT firms are very secretive, and very little is known about how they operate. Currently, there is little oversight over the algorithms these firms use, and very few people understand how they work.⁴³ Others take issue with the fact that high-frequency trading allows large companies to profit at the expense of the average investor and make money by simply trading more by having more powerful computers.⁴⁴

HFT has become possible through technological innovation but has disrupted the way the markets have traditionally operated by essentially creating a race of speed, benefiting the person who can access the fastest data link. Michael Lewis's *Flash Boys* is a book about high-frequency trading in the US markets, sharing experiences of different individuals on Wall Street. In the book's opening, a new high-speed data line was being constructed between a NASDAQ data center in New Jersey and the Chicago Mercantile Exchange, the world's largest options and futures contract exchange. The goal: achieve the lowest latency or delay between the two sites to trade as fast as the speed of light, the maximum a fiber line would allow. Existing fiber connections provided by AT&T and Verizon were fast but did follow a less direct route, therefore having ~1-2 milliseconds delay compared to the theoretical maximum. What is essential to understand is that the ability to trade faster gives one leverage over other market participants, putting individuals at a disadvantage. Being connected to the exchange with a shorter delay than a competitor can make the difference when trying to execute trades as fast as possible at the best price.⁴⁵

⁴² ESMA (European Securities and Markets Authority). (2014). High-frequency trading activity in EU equity markets. Retrieved from https://www.esma.europa.eu/sites/default/files/library/2015/11/esma20141_-_hft_activity_in_eu_equity_markets.pdf

⁴³ J. McGowan, Michael. (2010). The Rise of Computerized High Frequency Trading: Use and Controversy. Duke Law and Technology Review. 16.

⁴⁴ Chen, J. (2021, March 04). High-Frequency Trading (HFT) Definition. Retrieved from <https://www.investopedia.com/terms/h/high-frequency-trading.asp>.

⁴⁵ Lewis, Flash Boys, Chapter 1

The new data line was kept top secret, even from the construction workers physically laying the cable, to prevent attracting any unwanted attention. Once the line launched, it had cut the time to send a signal to and from New Jersey to Chicago to just 13 milliseconds but was only accessible to the Wall Street firms that the company operating the line chose to sell access to. They offered access to the line for between \$10-20 million/year but would allow the firms to make that back in cost improvement because of the better execution time. The provider of the new fiber line, Spread Networks, had taken a much shorter route than previous fiber lines and allowed users of the line to undercut their competitors on time, for which there was a huge demand.

As an example of how electronic trading changed how business was done, when Scott Fine was running Empire Capital in the late 1990s, he heard about this new service called 'Instinet', which would allow them to place trades electronically over the Internet, avoiding having to pick up the phone and call their broker at a bank. Once he heard about a service that could speed up trading, reducing cost and time wasted, he needed to get it and start using it as soon as he could. Instinet was an electronic securities order matching and information system that allowed members to display bids and offer quotes for stocks to do business and trade stocks. This system was the first to use technology to connect two stock market participants through an electronic system on a confidential basis.⁴⁶ During the stock market crash of 1987, traders did not pick up the phones for calls from clients because of the sudden decline in the market overall. Despite that, those that had electronic trading set up could still trade despite the turmoil. Since that event, electronic trading has become highly demanded since it could continue working in times of market uncertainty and, in this case, when human traders rebel.

The speed at which computers could trade was changing financial markets in ways that most people could not understand at the time. This newfound pace allows for a new kind of trading, which means that the faster someone's connection to the exchange, the more someone could trade, and the better the price

⁴⁶ Chen, J. (2020, November 09). Instinet. Retrieved from <https://www.investopedia.com/terms/i/instinet.asp>.

someone can get more consistently.⁴⁷ On an average trading day on the NYSE in 1970, about 10 million shares changed hands. In 2020, up to 3 billion shares changed hands on the NYSE alone in one day. In just under 50 years, stock trading volume has increased about 300 times due to the rise of computing and algorithmic trading.⁴⁸ The massive increase in trading shows how computing changed everything for the stock market and how people trade, which was constantly evolving as the Internet expanded and became more accessible over time.

Chapter 3: Effects of digitalization over time

Access to information

The Internet has made it incredibly easy for anyone to access financial services and enter the market. With services like Charles Schwab, E-Trade, or Fidelity, anybody with an Internet connection can buy and sell shares on the stock market. Those e-trading firms are some of the most successful financial firms of the last two decades. The trend of online trading took off from 1995 to mid-2000, where investors opened 12.5 million online trading accounts.⁴⁹ With lower fees than traditional brokerages, online brokerages took off in popularity. As of 2015, Approximately 6 in 10 households in the United States owned securities investments, according to an SEC report. However, only 3 in 10 had taxable accounts, meaning fewer people were investing for gain, and more were saving for retirement. At Charles Schwab, a leading brokerage firm, the share of daily trades made online increased from less than 25% in 1995 to 80% in 2002. The cost of trading online also is as much as 79% less than traditional broker-assisted trades.⁵⁰ Lower costs and more companies offering online brokerage services benefit investors by making it easy for someone without lots of startup capital to be an investor and be active in the stock market.

⁴⁷ Kessler p.17

⁴⁸ New York Stock Exchange, Trading Volume Data

⁴⁹ Barber, B. M., & Odean, T. (2001). The Internet and the Investor. *Journal of Economic Perspectives*, 15(1), 41-54. doi:10.1257/jep.15.1.41

⁵⁰ Bogan, V. (2008). Stock Market Participation and the Internet. *Journal of Financial and Quantitative Analysis*, 43(01), 191. doi:10.1017/s0022109000002799

Another effect of the Internet is a significant improvement in the accessibility of information. Professor Nicholas Economides of NYU Stern referred to it as the “democratization of the trading process,” meaning that information that was once only available to analysts is available to anyone through the Internet.⁵¹ Internet search engines made it possible for the public to access data on any publicly traded company, enabling anyone with interest to learn the skills to make informed trading decisions. Websites such as Seeking Alpha or Stock Twits allow investors to post research and commentary pieces, which they do online for all investors of a specific stock to see. By doing so, research and fundamental analysis get shared more democratically. Still, the “free” research online is often designed to sway the readers in the direction the author is leaning to, potentially misleading investors who do not do their own research.

Brokerage firms have also invested in increasing the amount of information available to their customers because their online services lack a traditional broker's one-on-one experience. Brokers generally provide stock price data, trends, earnings information, research, and price targets to customers to make educated decisions when buying and selling stocks.⁵² Services like Yahoo! Finance are free of charge and provide real-time stock price data and research, something most services cannot afford to offer.

Faster, and from anywhere

Being able to trade from anywhere, on any device, has given investors freedom they never had before. In 1982, E-Trade was founded and began executing trades over the Internet on behalf of their customers. The popularity of online trading began to take off mainly due to easily accessible information, the simplicity of electronic trading, and relatively low fixed costs to process a trade.⁵³ Reflecting the growth and popularity of online trading, E-Trade's revenues went from \$15 million in 1992 to \$142.7 million in

⁵¹ Economides, N. (2001). The impact of the Internet on financial markets;

http://www.stern.nyu.edu/networks/Economides_The_Impact_of_the_Internet_on_financial_markets.pdf

⁵² Bogan, V. (2008). Stock Market Participation and the Internet. *Journal of Financial and Quantitative Analysis*, 43(01), 191. doi:10.1017/s0022109000002799

⁵³ Diaz-Rainey, I., Ibikunle, G., & Mention, A. L. (2015). The technological transformation of capital markets. *Technological Forecasting and Social Change*, 99, 277–284. Page 4. <https://doi.org/10.1016/j.techfore.2015.08.006>

1996; it was rated as the fastest-growing company in America that year.⁵⁴ Since then, hundreds of online brokers have entered the market. Customers can now choose from a multitude of different online brokerage services, such as TD, Ameritrade, E-Trade, Fidelity, and Robinhood. Each of these services is easily accessible 24/7 via the Internet.

Every retail brokerage has an app now, allowing customers to log in and check their portfolios, place trades, check quotes on stocks, and access many brokerage features from the palm of their hand. Robinhood states on their website that their platform is “supported in almost all countries, except for Cuba, Iran, North Korea, Syria, and the Crimea region of Ukraine.”⁵⁵ If it were not for conflict and trade restrictions placed on those countries and regions, an investor would be able to be anywhere on earth and trade using some form of Internet connection.

As a result of the expansion and popularity of the Internet, banks and other financial companies have had to adapt to the changing technological landscape. Customers appreciate the simplicity and ease of using online interfaces and mobile applications to check their balances, pay bills, or arrange transfers. When it comes to investing, making a phone call to place trades has been replaced by a few taps on an app or computer. Computers have also replaced many jobs that people used to earn a salary to do, eliminating careers while creating new tech-based ones, including programmers and online customer service people. For example, when you place a trade on E-Trade, no intermediary or broker is needed to place that trade. All of it is done automatically, with people simply there to oversee the algorithms. Citigroup predicted in 2017 that over the next decade⁵⁶ over 1.7 million jobs would be lost as banks digitize their operations. Computers have replaced many roles that were important before the adoption of technology. Before the Internet, trading was possible by visiting a broker in person or calling them over the telephone. Orders

⁵⁴ E-Trade 10-K Filing, 1998

⁵⁵ Traveling with Robinhood. (n.d.). Retrieved from <https://robinhood.com/us/en/support/articles/traveling-with-robinhood/>.

⁵⁶ Arnold, M. (2017, January 17). How finance is being taken over by tech. Retrieved from <https://www.ft.com/content/2f6f5ba4-dc97-11e6-86ac-f253db7791c6>

could take days, whereas now trades can be fulfilled in milliseconds and without any human interaction, allowing companies to become leaner on how many people they employ.

Chapter 4: The rise of Robinhood

What is Robinhood?

Trading on the stock market has historically been viewed as a pursuit confined to noisy, bustling stock exchanges or Wall Street offices, with frantic brokers yelling at each other trying to make last-minute deals to boost their portfolios. As financial technology or “fintech” disrupts the financial services industry, this once exclusive activity is now being made available to the public in the comfort of their own home or just about anywhere else, if they have access to the Internet. New fintech firms are entering the market, allowing anyone to access the investing world by downloading an app on their phone. One of the pioneers of bringing stock trading to your fingertips was Robinhood, a digital start-up based in Menlo Park, California.

Launched in 2013, Robinhood was founded by two Stanford University alums who had worked on building high-frequency trading platforms for financial firms in New York. While working at hedge funds, they “realized institutions were paying fractions of a penny for trading and transactions,” which inspired them to use their prior expertise to allow anyone to have the same ability to trade cheaply, said co-founder Vladimir Tenev in an interview.⁵⁷

⁵⁷ Touryalai, H. (2020, December 16). Forget \$10 Trades, Meet Robinhood: New Brokerage Targets Millennials with Little Cash. Retrieved from <https://www.forbes.com/sites/halahtouryalai/2014/02/26/forget-10-trades-meet-robinhood-new-brokerage-targets-millennials-with-little-cash/?sh=54c0f3877f48>.

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Another effect of the Internet is a significant improvement in the accessibility of information. Professor Economides of NYU referred to it as the “democratization of the trading process,” meaning that information that was once only available to analysts is available to anyone through the Internet.⁶⁰ Internet search engines made it possible for the public to access data on any publicly traded company, enabling anyone with interest to learn the skills to make informed trading decisions. Websites such as Seeking Alpha or Stock Twits allow investors to post research and commentary pieces, which they do online for all investors of a specific stock to see. By doing so, research and fundamental analysis get shared more

⁵⁸ Barber, B. M., & Odean, T. (2001). The Internet and the Investor. *Journal of Economic Perspectives*, 15(1), 41-54. doi:10.1257/jep.15.1.41

⁵⁹ Bogan, V. (2008). Stock Market Participation and the Internet. *Journal of Financial and Quantitative Analysis*, 43(01), 191. doi:10.1017/s0022109000002799

⁶⁰ Economides, N. (2001). The impact of the Internet on financial markets;
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Every retail brokerage has an app now, allowing customers to log in and check their portfolios, place trades, check quotes on stocks, and access many brokerage features from the palm of their hand. Robinhood states on their website that their platform is “supported in almost all countries, except for Cuba,

⁶¹ Bogan, V. (2008). Stock Market Participation and the Internet. *Journal of Financial and Quantitative Analysis*, 43(01), 191. doi:10.1017/s0022109000002799

⁶² Diaz-Rainey, I., Ibikunle, G., & Mention, A. L. (2015). The technological transformation of capital markets. *Technological Forecasting and Social Change*, 99, 277–284. Page 4. <https://doi.org/10.1016/j.techfore.2015.08.006>

Iran, North Korea, Syria, and the Crimea region of Ukraine.”⁶³ If it were not for conflict and trade restrictions placed on those countries and regions, an investor would be able to be anywhere on earth and trade using some form of Internet connection.

As a result of the expansion and popularity of the Internet, banks and other financial companies have had to adapt to the changing technological landscape. Customers appreciate the simplicity and ease of using online interfaces and mobile applications to check their balances, pay bills, or arrange transfers. When it comes to investing, making a phone call to place trades has been replaced by a few taps on an app or computer. Computers have also replaced many jobs that people used to earn a salary to do, eliminating careers while creating new tech-based ones, including programmers and online customer service people. For example, when you place a trade on E-Trade, no intermediary or broker is needed to place that trade. All of it is done automatically, with people simply there to oversee the algorithms. Citigroup predicted in 2017 that over the next decade, over 1.7 million jobs would be lost as banks digitize their operations.⁶⁴ Computers have replaced many roles that were important before the adoption of technology. Before the Internet, trading was possible by visiting a broker in person or calling them over the telephone. Orders could take days, whereas now trades can be fulfilled in milliseconds and without any human interaction, allowing companies to become leaner on how many people they employ.

Chapter 4: The rise of Robinhood

What is Robinhood?

Trading on the stock market has historically been viewed as a pursuit confined to noisy, bustling stock exchanges or Wall Street offices, with frantic brokers yelling at each other trying to make last-minute deals to boost their portfolios. As financial technology or “fintech” disrupts the financial services industry, this once exclusive activity is now being made available to the public in the comfort of their own home or

⁶³ Traveling with Robinhood. (n.d.). Retrieved from <https://robinhood.com/us/en/support/articles/traveling-with-robinhood/>.

⁶⁴ Arnold, M. (2017, January 17). How finance is being taken over by tech. Retrieved from <https://www.ft.com/content/2f6f5ba4-dc97-11e6-86ac-f253db7791c6>

just about anywhere else, if they have access to the Internet. New fintech firms are entering the market, allowing anyone to access the investing world by downloading an app on their phone. One of the pioneers of bringing stock trading to your fingertips was Robinhood, a digital start-up based in Menlo Park, California.

Launched in 2013, Robinhood was founded by two Stanford University alums who had worked on building high-frequency trading platforms for financial firms in New York. While working at hedge funds, they “realized institutions were paying fractions of a penny for trading and transactions,” which inspired them to use their prior expertise to allow anyone to have the same ability to trade cheaply, said co-founder Vladimir Tenev in an interview.⁶⁵

The name “Robinhood” is derived from “a legendary English outlaw ... the hero of many ballads, who robbed the rich to give to the poor.”⁶⁶ As stated on their website, their mission is to “democratize finance for all,” and they believe that “everyone should have access to the financial markets.”⁶⁷ When it was launched, the Robinhood platform was revolutionary. It served as an alternative to traditional, costly investment methods and had benefits like crowdsourced trading advice and the chance to get free stock for inviting friends. Traditionally, brokerages charged \$5-10 in commissions on each trade and had a minimum account value of somewhere between \$500 and \$5,000. Robinhood had neither, allowing people to use it differently from typical brokerages and avoid fees on trades. Co-founder Baiju Bhatt said on CNBC around the time of the launch in 2015 that “we see Robinhood as unlocking the micro investor market.”⁶⁸

⁶⁵ Touryalai, H. (2020, December 16). Forget \$10 Trades, Meet Robinhood: New Brokerage Targets Millennials with Little Cash. Retrieved from <https://www.forbes.com/sites/halahtouryalai/2014/02/26/forget-10-trades-meet-robinhood-new-brokerage-targets-millennials-with-little-cash/?sh=54c0f3877f48>.

⁶⁶ Robin hood definition. Retrieved from <https://www.dictionary.com/browse/robin--hood>.

⁶⁷ Robinhood Securities. (n.d.). Our Mission. Retrieved from <https://robinhood.com/us/en/support/articles/our-mission/>

⁶⁸ Nasr, R. (2015, March 12). Robinhood creators: 'Unlocking the microinvestor market'. Retrieved from <https://www.cnbc.com/2015/03/12/robinhood-creators-unlocking-the-microinvestor-market.html>

How does Robinhood operate?

Robinhood can avoid charging a commission for trades because it was founded with efficiency in mind. Large traditional brokers such as Charles Schwab or E-Trade have brick and mortar offices near their clients and offer them services including research, market commentary, 24/7 customer support, and investment education, all of which come at a cost. Robinhood has employed the strategy to be as lean as possible and use financial technology to bring the efficiency of an institutional trading firm to retail investors who trade independently, providing an aggregate of information from the Internet instead of standard in-house professional investing advice.

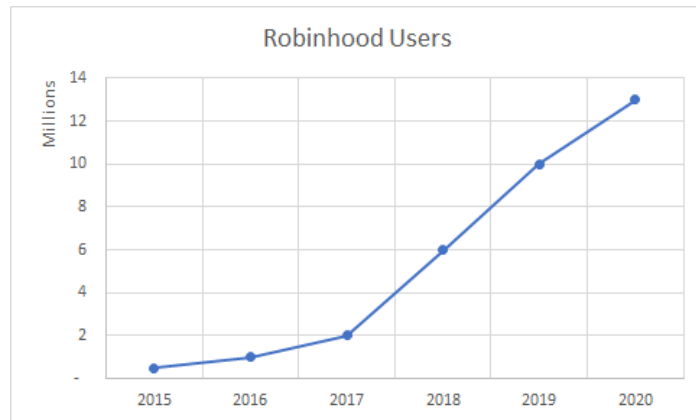


Figure 3: Total reported Robinhood users

Source: Company releases and SEC filings

Free trading was an easy sell for many people. Robinhood was popular even before launching. In 2014, 340,000 people had signed up to Robinhood's waitlist, and by March 2015, a month before it launched, that figure had doubled to 700,000.⁶⁹ At the same time, the company had secured millions of dollars in venture capital funding from prominent Silicon Valley investors like Sequoia Capital, Google Ventures, and Andreessen Horowitz and was continuing to raise money.

Disrupting the industry

During the week of September 30th, 2019, six years after Robinhood was founded and in response to their success, major brokerages Charles Schwab, TD Ameritrade, and E-Trade announced that they

⁶⁹ Robinhood Revenue and Usage Statistics (2021). (2021, May 06). Retrieved from <https://www.businessofapps.com/data/robinhood-statistics/>

would no longer charge commissions for individual stocks, ETFs, and options trades.⁷⁰ The major brokerages' move to scrap trading fees leveled the playing field for clients looking for cost savings. For several years, Robinhood had a competitive advantage on pricing because they offered the same service at no cost. Now all brokerages offer the same advantage, showing how they forced the industry to innovate and change long-standing fee structures.

When every competitor began offering zero-commission trades, Robinhood's significant competitive advantage faded for those seeking a more reliable and established company to invest with and desire the services that those companies offer. If a more reputable broker can provide the same service for the same price as Robinhood, it makes sense to go with the one that offers more security and features and people on the other end to guide you through any issues an investor may have. While he is undoubtedly biased, the CEO of Charles Schwab said in an interview, "if you are an account holder at a firm that is charging a zero commission, you are just paying in other ways — whether it's in yields on cash, whether it's in quality of execution." Robinhood has had plenty of trading issues and technical glitches that have given it a reputation of not being as reliable as more prominent, traditional brokerage firms.⁷¹

Robinhood can afford to charge zero commissions for trades done on its platform because of a system called 'payment for order flow.' Generally, Robinhood orders are much smaller in dollar value, as the platform is oriented towards newer investors who may not have or want to put up large amounts of capital. Smaller orders are typically less desirable when trading, as it is more challenging to find a buyer for a smaller order than a bigger one. A study conducted by the SEC in 2000 defined payment for order flow as "a method of transferring some of the trading profits from market making to the brokers that route customer orders to specialists for execution."⁷² In other words, a payment from the firm that executes the

⁷⁰ Rooney, K. (2019, October 04). Battle for zero trading fees threatens Robinhood's business model and next leg of growth. Retrieved from <https://www.cnbc.com/2019/10/04/battle-for-zero-trading-fees-pressures-robinhoods-next-leg-of-growth.html>

⁷¹ Ibid

⁷² U.S. Securities and Exchange Commission. (2000, December). Special Study: Payment for Order Flow and Internalization in the Options Markets. Retrieved from <https://www.sec.gov/news/studies/ordpay.htm>

trade (or market makers) to the brokerage firm for bringing them the business.⁷³ By separating the smaller retail orders that will not affect the market as much, the market maker can then bundle those trades together and execute them at a better price. By bundling trades together, market makers can more reliably profit off the trade, which in turn allows them to pay for order flow. Ken Griffin, CEO of Citadel, which has a market-making arm, said that payment for order flow is a “key reason” that retail investors can trade with little to no commission fees like they do today. Robinhood generates around half its revenue from payment for order flow, raising \$682 million in revenue. The company generates the other 50 percent of its income from payment-for-order-flow from account interest and Robinhood Gold, which lets users trade on margin, deploy deposits faster, and provides access to Morningstar research reports.⁷⁴

Many find this system controversial. It incentivizes Robinhood and other brokerages to fulfill orders with the market maker that will give them the highest payment for their order flow, not necessarily executing trades the fastest. Ironically, payment for order flow was pioneered by Bernie Madoff, who passed away in jail in early 2021 after being convicted of running a massive Ponzi scheme.⁷⁵ For the average investor, the payment for order flow system could cause issues if their broker is routing orders to market makers that would benefit them and not put their customer in the best position possible. For most investors, it would be such a tiny difference because they do not trade often. Investors who trade more often should know about how their brokerage routes orders, so they are not impacted by price fluctuations because their broker is not executing their order with the fastest market maker possible.

⁷³ Carey, T. W. (2021, April 14). What is Payment for Order Flow (PFOF). Retrieved from <https://www.investopedia.com/terms/p/paymentoforderflow.asp>

⁷⁴ Cheung, B. (2021, February 18). Payments for order flow almost tripled in 2020 at Robinhood, other brokerages. Retrieved from <https://finance.yahoo.com/news/payments-for-order-flow-exploded-in-2020-215034948.html>

⁷⁵ Balsamo, M. (2021, April 15). Ponzi schemer Bernie Madoff dies in prison at 82. Retrieved from <https://apnews.com/article/bernie-madoff-dead-9d9bd8065708384e0bf0c840bd1ae711>;

Crowley, J. (2021, February 18). What is "payment for order flow"? Robinhood CEO talks "PFOF" in GameStop hearing. Retrieved from <https://www.newsweek.com/what-payment-order-flow-pfof-1570268>

In late 2020, Robinhood was charged by the SEC with “misleading customers about revenue sources and failing to satisfy the duty of best execution.”⁷⁶ The charges detailed that “between 2015 and late 2018, Robinhood made misleading statements and omissions in customer communications, including in FAQ pages on its website, about its largest revenue source when describing how it made money – namely, payments from trading firms in exchange for Robinhood sending its customer orders to those firms for execution, also known as ‘payment for order flow.’” The announcement of the charges also found that “one of Robinhood’s selling points to customers was that trading was “commission-free,” but due in large part to its unusually high payment for order flow rates, Robinhood customers’ orders were executed at prices that were inferior to other brokers’ prices,” proving that the system allows brokerages to profit at their customers’ expense. Robinhood paid a \$65 million fine to settle the charges on December 17th, 2020 and has promised to improve transparency about revenue sources. Since the settlement, they now have a page on their website’s Q&A describing how stock orders are routed on their platform and more pages highlighting how their order flow system saves its customers money. It clearly outlines what payment for order flow is and how Robinhood uses it to provide free trades. Robinhood says that it uses the National Best Bid and Offer (NBBO) system, which is “the best available bid and ask prices when buying and selling securities for a customer,” or better. Robinhood claims 94.53% of their orders get executed at the best price or better.⁷⁷ They also say that for every 100 shares they trade, they save customers on average \$1.93 in price improvement.

In my conversation with Tom Joyce, I discovered that he takes Robinhood’s optimism on their execution quality with a grain of salt. Joyce believes that executing trades on a “best-effort” basis is fine, but it can open loopholes. Executing something on a “best effort basis” allows “market makers to have more leeway” in which they can trade in and potentially make a higher spread, meaning more money on a

⁷⁶ SEC. (2020, December 17). SEC Charges Robinhood Financial With Misleading Customers About Revenue Sources and Failing to Satisfy Duty of Best Execution. Retrieved from <https://www.sec.gov/news/press-release/2020-321>

⁷⁷ Robinhood Securities. (n.d.). Execution Quality. Retrieved from <https://robinhood.com/us/en/about-us/our-execution-quality/>

trade. While he was CEO of Knight Capital, he was always there to negotiate with brokerage firms on payment for order flow contracts. He told me that established brokers like Fidelity or Charles Schwab would force market makers like Knight or Citadel to agree to specific parameters of execution quality. Those parameters included having price improvement on all top S&P companies and having the order returned in one second. As Joyce explained it, if you have just a “best-effort” system with no parameters, “you can take an order and kind of do what you want with it.” Execution stats are public, so it is not in a brokerage firm’s best interest to have poor execution. More requirements on the market-maker allow for tighter spreads.

Joyce also said that they had a good sense of what kind of business they could get from each kind of brokerage. They “knew that 20% of Wells Fargo’s business were really day traders in disguise,” which would be hard to make money on since they knew exactly what pricing to expect. Whereas “30% of Wells Fargo’s order flow could be mom and pop [investors] who did not give a hoot about price improvement because they were buying blue-chip stocks that they will hold for years,” and market makers like Knight could make more money from trading for those kinds of retail clients. As previously mentioned, Robinhood has 94.53% of their orders executed at the NBBO or better, but Fidelity executes 98.7% of their orders to the same standard over the same period.⁷⁸ While it is a slight percentage difference, if you are frequently trading, the price improvement that is lost using Robinhood can be noticeable. The difference becomes profit to the market-maker.

While payment for order flow has its downsides, overall, the concept typically allows individual investors to ensure the best execution in an often uncertain market with many prominent and very wealthy players.⁷⁹ The payment for order flow would come up again in January 2021, when Robinhood halted trading of popular stocks on the platform and was accused of allowing the market makers to dictate the platform’s actions and what their customers can and cannot trade.

⁷⁸ Fidelity Clearing Solutions. (2021, February 26). Trade Execution Quality Statistics. Retrieved from https://clearingcustody.fidelity.com/app/item/RD_13569_21697.html

⁷⁹ Tabb, L. (2019, October 18). Why payment for order flow is a good deal for investors. Retrieved from <https://www.ft.com/content/b745ba00-ef1d-11e9-bfa4-b25f11f42901>

Rise of retail investment

Despite concerns over the young brokerage's reliability, Robinhood has continued to multiply in size as people continue to sign up for the platform, following the general trend of more retail investors entering the market. For context, a retail investor is an individual who buys and sells securities, mutual funds, or ETFs for their personal, taxable investment account. Retail investors generally trade in smaller quantities and less frequently than institutional investors like mutual funds, pension funds, or endowments. Generally, retail investors are viewed as less knowledgeable and skilled than professional investors. Despite them being behind, with the availability of information on the Internet and the ability to trade from anywhere, retail investors are quickly catching up to their institutional peers.

Back in 1950, 90% of the stock in US companies was owned by retail investors. Today, retail investors own less than 30%. While there has not been any public historical data to track the level of retail investor trading, recently, the NYSE has shown that they represent less than 2% of trading volume for NYSE listed companies.⁸⁰ According to Bloomberg Intelligence, the share of US equity trading volume that individual investors make up has been between 10-15% for the last ten years, and in 2020 is estimated to have jumped to around 20%. See the chart to the right. As the market rebounded from the lows, retail investors accounted for as much as 25% of the stock market's activity in July 2020, according to Joe Mecane, head of execution services at Citadel Securities, in an interview on Bloomberg.⁸¹



Figure 4: Individual investors share of US Equity trading volume.

Source: Bloomberg Intelligence via The Wall Street Journal

⁸⁰ Davis, Alicia J. "A Requiem for the Retail Investor?" *Va. L. Rev.* 95, no. 4 (2009): 1105.

⁸¹ Bloomberg News. (2020, July 9). Citadel Securities' Mecane Says Volatility Behind Rise in Retail Investing. Retrieved from <https://www.bloomberg.com/news/videos/2020-07-09/citadel-s-mecane-says-volatility-behind-rise-in-retail-investing-video>

While the retail investor's impact on the market appeared to have been minimalized compared to the massive institutional investors for some time, in 2020 and 2021, there was constant press and talk about how individual investors are taking more of a share of the trading volume and being more active.

The trend of heightened retail investor involvement in the market unlikely to go away as well, mainly in part due to apps like Robinhood that continue to draw new investors into the market with new, previously uninvested capital. Ordinary people are deploying their savings through brokerages like Robinhood, which allows anyone to be an investor. With its roots in Silicon Valley, Robinhood is the closest to a tech company of all the retail brokerage platforms. In addition to lower costs, Robinhood changed how people interact with the stock market on their phones by incorporating game-like aspects to their platform. Robinhood uses visual effects such as confetti, push notifications to maintain people's engagement. The gamification of stock trading allows inexperienced investors to be comfortable in a risky market, where investments can be uncertain if not performed carefully.

COVID impact on trading

What was initially thought of as something that could never happen, because of the pandemic, in late February 2020, much of the United States and the world was under lockdown, choking businesses of their clients and causing people to shift to an entirely new work-from-home lifestyle. College students returned home to classes taught on Zoom, a video conferencing app that became crucial to life in 2020, and the world stayed at home and went online. Since Robinhood and other online brokerages allow people to sign up to trade in a

few clicks, with zero upfront cost, millions of people have become investors for the first time or have become more active if they already had a brokerage account.

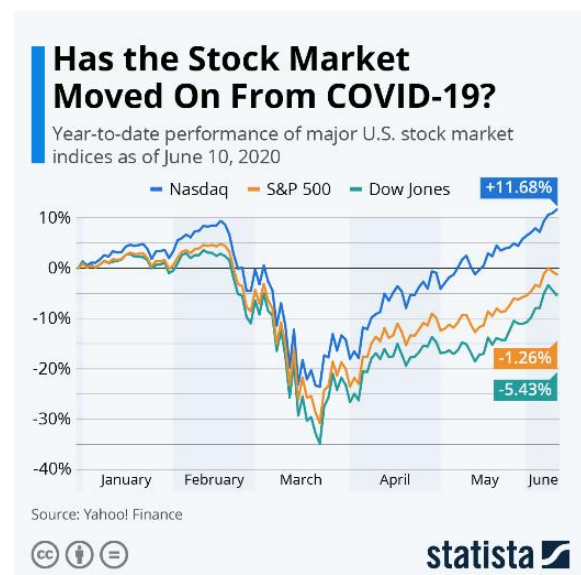


Figure 5: Stock market performance, 1st half of 2020

A significant catalyst for retail investing was COVID-19. In the first quarter of 2020, when the Coronavirus was first taking hold, putting millions of people under lockdown, people were bored. Sports that one could typically bet on were canceled, and Netflix only has so many shows. Many people turned their attention to the stock market, especially since it had taken such a hit in March because of lockdowns and uncertainty. Between Feb. 12 and March 23, the Dow lost a stunning 37% of its value. On March 16 alone, the Dow plummeted about 3,000 points, losing 12.9%, as investors worried about what COVID would do to the economy. The drop in stock prices was so significant and fast that it triggered multiple trading halts that day. The NYSE also suspended trading several times during those days.⁸² Many stocks looked like good buying opportunities at COVID lows. Figure 3 showed how the market crashed in March and rebounded directly after, allowing people to get into the market and take advantage of ‘discounts.’

For the stock market, the biggest hit was taken in March. Despite the impending pandemic that only got worse, the market almost immediately rebounded and continued to rally throughout the rest of 2020. One of the sectors that benefited from the pandemic and lockdowns the most was technology companies that provided products that people used at home to continue

COMPANY	TICKER	INDUSTRY	PRICE CHANGE - 2020
Tesla Inc.	TSLA	Motor Vehicles	743%
Moderna Inc.	MRNA	Biotechnology	434%
Peloton Interactive Inc. Class A	PTON	Other Consumer Services	434%
Zoom Video Communications Inc. Class A	ZM	Software	396%
Pinduoduo Inc. Sponsored ADR Class A	PDD	Internet Retail	370%
DocuSign Inc.	DOCU	Software	200%
MercadoLibre Inc.	MELI	Internet Software/Services	193%
Okta Inc. Class A	OKTA	Software	120%
Nvidia Corp.	NVDA	Semiconductors	122%
PayPal Holdings Inc.	PYPL	Data Processing Services	117%
Advanced Micro Devices Inc.	AMD	Semiconductors	100%
Cadence Design Systems Inc.	CDNS	Software	97%
Atlassian Corp. PLC Class A	TEAM	Software	94%
Idexx Laboratories Inc.	IDXX	Medical Specialties	91%
Align Technology Inc.	ALGN	Medical Specialties	92%
Apple Inc.	AAPL	Telecommunications Equipment	81%
Synopsys Inc.	SNPS	Software	86%
Amazon.com Inc.	AMZN	Internet Retail	76%
Marvell Technology Group Ltd.	MRVL	Semiconductors	79%
T-Mobile US Inc.	TMUS	Wireless Telecommunications	72%

Figure 6: NASDAQ 100, top performing companies of 2020

living as normally as possible. People were at home, using technologies that were now essential to press on with work and life. As you can see in Figure 4, aside from Tesla, the top-performing companies in the NASDAQ 100 were a result of COVID-related demand shifts, and investors seized the opportunity.

Robinhood has likely well over 13 million traders and has already had a significant impact on the way stocks trade hands by making them free to trade and accessible in a straightforward way on your phone. 2020 was a whirlwind of a year, but for Robinhood, it was a particularly positive one. For a large portion

⁸² Horsley, S., & Martin, R. (2020, March 12). Stock Market Tumbles, Trading Briefly Halts. Retrieved from <https://www.npr.org/2020/03/12/814922531/stock-market-tumbles-trading-briefly-halts>

of the year, people were under lockdown. They turned to their phones to trade the stock market, often driven by information and logic that people did not traditionally invest with, like social media talk and sentiment. Even the federal government's response to the lockdown encouraged retail investing. In May 2020, the \$1,200 stimulus check provided cash to Americans right when they needed it most. According to the results of a SoFi/Centiment Research survey of 2,054 clients, 83% of those who responded received government stimulus checks, and half said they put some of their stimulus money into the stock market, showing peoples willingness to deploy any free capital they have into the stock market.⁸³

To prove it, data provided by JMP Securities Brokerages shows that in 2020 some brokerages saw double the daily website visits each month, demonstrating how much more attention people were paying to their investments during the pandemic.

On top of Robinhood's stock trading service becoming more popular, in early 2018, the company launched a cryptocurrency trading feature for users of their platform to trade cryptocurrencies on the same app. The service

allows users to buy and sell Bitcoin (BTC), Ethereum (ETH), and a few other crypto coins through their platform, with no commission or fees, unlike rivals. Over 1 million people were on the wait-list for "Robinhood Crypto" in the first five days after it was announced. Trading in cryptocurrencies has exploded since the beginning of 2017, and the coin markets have witnessed a surge of new investors. Coinbase, by far the most popular venue for cryptocurrency trading in North America, boasts more users than Charles Schwab, with more than 20 million users and more than \$150 billion in cryptocurrency trades. Coinbase's

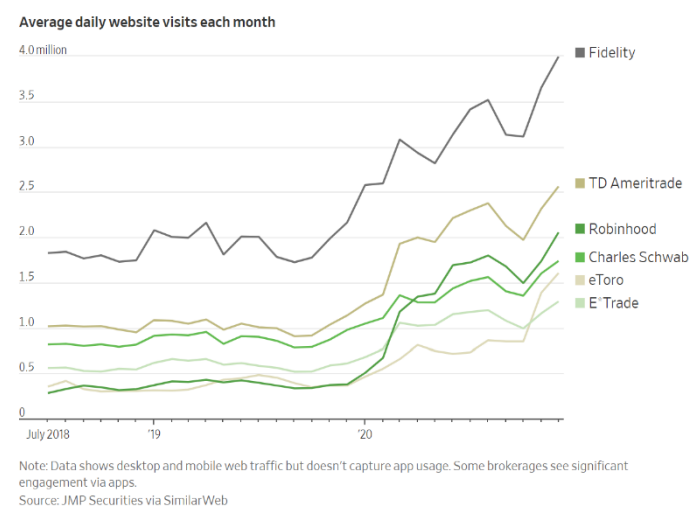


Figure 7: Average major brokerage daily website visits each month.

Source: JMP Securities via Similarweb, from the Wall Street Journal

⁸³ SoFi Financial. (2020, July 14). Taking Stock of 2020...So Far. Retrieved from <https://www.sofi.com/blog/taking-stock-of-2020-so-far/>

trading fees in the US are between 1.5% and 4%, but Robinhood charges no fees for the same trades, yet again undercutting an established industry.

Chapter 5: GameStop (GME)

Made more straightforward by the Internet and platforms like Robinhood, throughout 2020, new investors entered the market trying to make money during the COVID-19 pandemic hoping to make money.

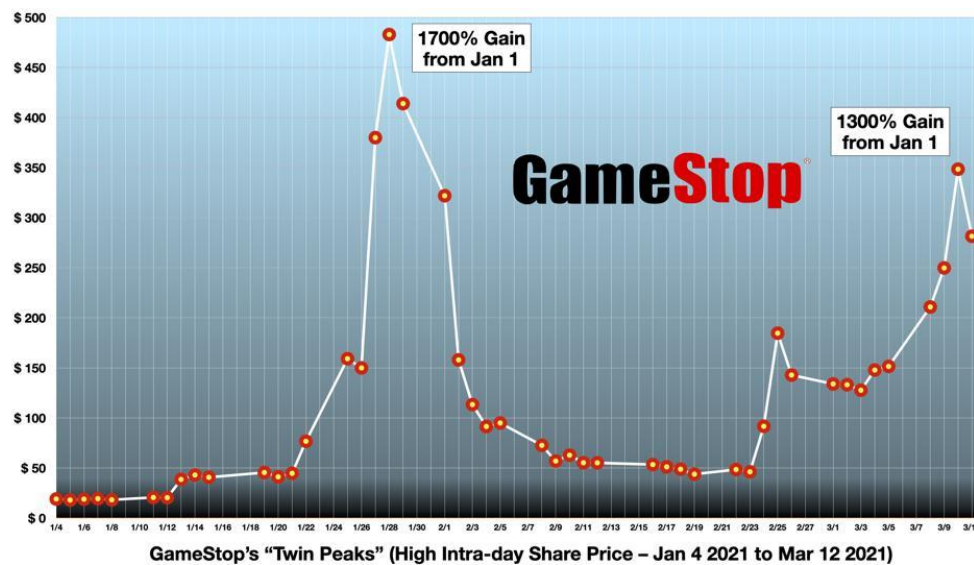


Figure 8: GameStop stock chart over 3 years leading up to January 2021.

In late January 2021, the stock of GameStop, a video game retailer, shot up from \$17/share at the beginning of the month to a peak of \$500/share during pre-market trading on January 28th. For a few days, investors watched, stunned at how a stock can see such rapid gain. The gains were mainly attributed to a group of Robinhood traders communicating through a Reddit feed called r/WallStreetBets. However, at the same time, hedge funds were betting against the company, causing a short squeeze that resulted in GME's share price skyrocketing, some individual investors making small fortunes, and hedge funds losing billions.

While typically people invest in a company because they think its share price will go up, you can also invest in the opposite: the share price of a company going down and make money from it. The act of doing that is called *short selling*. Short selling is a practice in which the short-seller borrows shares and

then sells them right away, hoping to repurchase them later at a lower price. To close out the position, they give back the borrowed shares and then keep the difference as profit. The difference between short selling and buying a position that you think will appreciate is that the risk of losses can be greater than your initial invested capital when short selling because a stock price can always go up.

On the other hand, just owning the stock, an investor can only lose his investment if the stock goes to \$0. Short sellers have positions on stocks they think will go down, so if it goes up because of positive news, or in the case of GME, retail investors buying the stock, the person that is short can face substantial losses. They would have to buy back the shares at a higher price at a loss to cover their position.

GameStop is a chain of American video game stores, which had struggled in the years leading up to January 2021 because of a shift away from brick-and-mortar stores, competition from online retailers, as well as the effects of COVID-19 on in-person shopping experiences. As a result of all those factors, many hedge funds and investors who short companies professionally decided to short GameStop. It seemed almost a certainty that GameStop was going to fail, and investors thought it was an intelligent decision to short the stock to profit from the demise of old-school retail.

In early January 2021, GME and other companies with similarly negative outlooks were heavily shorted by hedge funds such as Melvin Capital and others, which short stocks professionally. On January 11th, GME shares rose after the company agreed to allow activist investor Ryan Cohen to join the company's board. This first step up in the share price drew attention to the company's massive amount of short interest and began to squeeze some of the shorts out because of the heightened share price. By January 22nd, approximately 140% of GameStop's public shares were sold short, meaning some shares had been lent and shorted again. According to a Goldman Sachs report, a

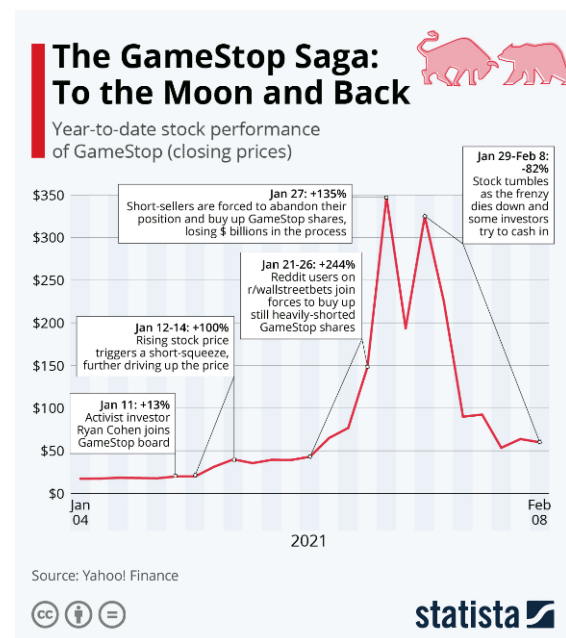


Figure 9: Share price of GME from 1/4/20 to 2/6/2020 with timeline annotations

Source: Statista, Yahoo Finance

company with more than 100% of a company's shares being sold short is unbelievably rare, having happened only 15 times in ten years.⁸⁴ At the same time, the stock was soaring. From January 21st to the 27th, GME shares multiplied in value, thereby squeezing the hedge funds that had shorted the stock. It is reported that in January, hedge funds lost nearly \$20 billion in January alone, partially because of the GameStop short squeeze.

While short squeezes are nothing new to the stock market and finance, there was something different about this one. Typically, short squeezes are caused by large investors or hedge funds having differing opinions on the future of a company's stock than one another. In this case, with GameStop and other heavily shorted stocks, it was people banding together on Reddit to go after hedge funds. Following the announcement of an activist investor on the board, and the potential to go after the poorly looked upon hedge funds, Reddit traders started buying GameStop stock and options on the stock to make a profit and 'screw over' the large investors. Some of them saw value in GameStop, and others just wanted to stick it to hedge funds that had shorted the shares.

r/WallStreetBets had 2-3 million users at the time, and many saw the posts of users on the platform telling them to buy the stock or buy risky options and did precisely that. Robinhood allows users to place options trades as well as just buying and selling stock. Despite options having the potential of being a precarious way to invest, 13% of Robinhood users trade options, which is millions of users that would likely have ever been exposed to options if it were not for the feature on Robinhood.⁸⁵ Many Reddit investors bought large amounts of out-of-the-money call options on GameStop, which caused dysfunction in the market. Those options would give the buyer the right to purchase the share at a higher price than what it was currently trading at, which the broker that issues the option would then hedge by buying the underlying

⁸⁴ Ponciano, J. (2021, February 11). Meme Stock Saga Officially Over? GameStop Short Interest Plunged 70% Amid \$20 Billion Loss. Retrieved from <https://www.forbes.com/sites/jonathanponciano/2021/02/10/meme-stock-saga-officially-over-gamestop-short-interest-plunged-70-amid-20-billion-loss/?sh=4f641cd9b213>

⁸⁵ Wilhelm, A. (2021, February 19). A fraction of Robinhood's users are driving its runaway growth. Retrieved from <https://techcrunch.com/2021/02/19/a-fraction-of-robinhoods-users-are-driving-its-runaway-growth/>

shares themselves.⁸⁶ The number of options trading and, as a result, stock being acquired to hedge the options drove the share price up. At the same time, investors piled into the stock, buying vast amounts of it, further driving the price up. The simultaneous buying of options and stock in record volumes caused GameStop's share price to soar, squeezing the hedge funds of their short positions and allowing investors to make fortunes if they timed their investments correctly.

One of the most famous members of the r/WallStreetBets forum is the aptly named user u/DeepFu**ingValue, also known as Roaring Kitty, who would later be revealed as Keith Gill. Keith is a 34-year-old former financial analyst that now invests his own money via an E-Trade account. After analyzing GameStop's business back in 2019, he believed that GameStop stock was potentially worth much more than what it was trading for at the time. Mr. Gill posted his findings on r/WallStreetBets and drew significant attention. One of the reasons that Mr. Gill became so well-known is because he managed to turn a \$53,000 investment into close to \$50 million at one point by buying stock and options in GameStop. He bought a position in GameStop back in 2019 and sat on it, hoping something would happen. Once it started to take off in January 2021, he posted update screenshots of his progress daily on Reddit. He generated a considerable following once his prediction came true and his trade started making him millions of dollars. While he was one of a handful of investors that made a killing on the rise of GME stock, most of the investors getting into it were hopping on the hype surrounding the stock, hoping to make some money for some entertainment. There was a significant risk, but as was being demonstrated publicly by Keith Gill, there were also significant gains to be had.

Millions of people were in on these so-called "meme stocks," even Elon Musk, CEO of Tesla, and SpaceX, tweeted "Gamestonk!!" on January 26th, when the stock closed up 92.7% on the day.⁸⁷ Chamath Palihapitiya, CEO of hedge fund Social Capital and active twitter user, was also a part of promoting the action surrounding GME. He tweeted the same day as Elon, "Lots of \$GME talk soooooo.... We bought

⁸⁶ Powell, J. (2021, January 25). GameStop can't stop going up. Retrieved from <https://www.ft.com/content/7aa60aa1-484f-4747-9136-cd0a560dd2d8>

⁸⁷ Musk, E. (2021, January 26). Gamestonk!! <https://t.co/RZtkDzAewJ>. Retrieved from <https://twitter.com/elonmusk/status/1354174279894642703?lang=en>

Feb \$115 calls on \$GME this morning. Let's goooooo!!!!!!!," following that tweet up with "ride or die." These famous and successful figures getting behind GameStop was another factor in the popularity of the stock and similar companies. It became a joke to them, and these billionaires were happy to throw some of their money at it as a highly speculative bet. Others bet money they did not have in hopes of mimicking Elon and Chamath's trades. Either way, celebrities promoting GameStop and the crazy gain in its share price showed people that some of the most successful investors were getting in on the action and created a sense of FOMO (fear of missing out).

All this combined led to record-setting trading volumes over those couple of days in late January. According to Bloomberg, On January 27th, trading volumes in the US by share count exceeded the peak set in October 2008 during the financial crisis and was the third-highest in dollar terms within the last 13 years on record. On the same day, GME shares were up 1,500 percent from what they were trading at two weeks before, and the volatility had triggered market circuit breakers and halted trading several times. According to Dow Jones market data, more than 175,000,000 shares of GameStop were traded on January 25th alone, blowing past its average volume over the past 30 days of just below 30 million shares per day.

Millions of people were betting big on the stock and being very public about it. Users of r/WallStreetBets were posting screenshots of 'gains porn' on Reddit for everyone to see, be jealous of, and in some cases could mislead people into buying in at the wrong time, potentially leading to losses. Mashable reported on January 27th that the r/WallStreetBets sub-Reddit was the fastest growing at the time, receiving 73 million page views in 24 hours. The community added 1.5 million users in a day and had 6 million members on January 29th.⁸⁸

Real issues arose for the brokerage during the market volatility caused by so many people buying and selling shares in a few companies. As a result, on January 28th, Robinhood suspended customers' ability to buy shares of GameStop and other similar stocks. Users were allowed only to sell their positions,

⁸⁸ Ghosh, S. (2021, January 29). Reddit group WallStreetBets hits 6 million users overnight after a wild week of trading antics. Retrieved from <https://www.businessinsider.com/wallstreetbets-fastest-growing-subreddit-hits-58-million-users-2021-1#:~:text=According to FrontpageMetrics, an unofficial,Thursday with 4.4 million members.>

not open new ones, or add to their existing holdings, locking them out of buying shares on the market. The brokerage issued a statement saying they “continuously monitor the markets and make changes where necessary. Considering recent volatility, we are restricting transactions for certain securities to position closing only.” The statement, posted on Robinhood's website and emailed to its users, went on to say, “amid significant market volatility, it is important as ever that we help customers stay informed.”⁸⁹ Immediately investors were furious, and many said they were leaving the platform for others that did not restrict their customers' trading. They indeed were not lying about the volatility. The abnormally high volume of trading of amateur investors on Robinhood during those few days in late January, many driven by social media, put a strain on Robinhood's balance sheet. Brokerage firms must keep a certain cash reserve to protect themselves against potential losses. The required reserve limit can increase quickly in volatile trading environments, which Robinhood said was happening to them.

Many assumed that Robinhood was protecting itself and market makers like Citadel instead of following their fiduciary responsibility to their investors and clients. As Robinhood receives a large portion of their revenue from market makers through payment for order flow, it seemed possible that if the market makers were losing money on GME trades being done by Robinhood users, they may ask Robinhood to stop the orders from coming. Citadel came into question because they are a middleman to ~40% of all retail investors trading at the time through their massive market-making arm.⁹⁰ People also argued that since they paid a \$65 million fine to the SEC in December 2020, they have a history of putting their primary revenue streams before their customers. Despite concerns of Robinhood not being trustworthy, they argued that they did it to protect their customers from a volatile market and the chance of them not being able to fill orders. “To be clear, this was a risk-management decision and was not made on the direction of the market makers we route to,” Robinhood said of the restrictions it imposed on their customers. The same

⁸⁹ Robinhood Securities. (2021, January 29). Keeping Customers Informed Through Market Volatility. Retrieved from <https://blog.robinhood.com/news/2021/1/28/keeping-customers-informed-through-market-volatility>

⁹⁰ Bloomberg News. (2020, July 9). Citadel Securities' Mecane Says Volatility Behind Rise in Retail Investing. Retrieved from <https://www.bloomberg.com/news/videos/2020-07-09/citadel-s-mecane-says-volatility-behind-rise-in-retail-investing-video>

story ties back to what I discussed earlier about Mr. Joyce's experience with "best-effort" execution, where the market-maker has more control over the amount of money made in trading than with brokers that have more stringent rules for execution.

In summary, what happened with GameStop in early 2021 was a perfect example of digital trading adding volatility to the market due to the sheer number of investors involved. It was both a good and bad situation. It was good because it allowed lots of people to make money. However, as I will describe, a lot did not, reflecting the downsides of encouraging inexperienced investors to invest in volatile stocks.

Chapter 6: How behaviors and investor decisions are changing

More trading is generally risky business

The amount of data and technology we have now can empower investors to make more informed decisions and predict how the market and stocks will do if they correctly interpret the vast amount of information available on the Internet. As I have outlined earlier, it is a fact that stock market trading has essentially evolved completely to adapt to the availability of technology that would improve how people trade in every way. Technologies invented in the past 30 years have allowed anyone to trade anywhere, anytime, and at lightning-fast speeds. Accelerated by lockdowns due to COVID-19 in 2020 and ease of access, retail trading has seen a massive resurgence in the past few years. In December of 2019, according to data compiled by Piper Sandler, retail trades averaged 13% of total trading share volume. By the end of 2020, that had almost doubled to 23%, showing how retail investors are taking more market share from institutional investors. Rich Repetto, an analyst that tracks trading at Piper Sandler, said in an interview by CNBC that "not only did the retail share of trading goes up, but they drove volumes much higher." He went on to say that trading overall in 2020 was up 55% from 2019, much of it driven by retail investors. Even in

the first few months of 2021, the trend continued to show, as average daily share volumes year-to-date are up 42% as of the 18th of February.⁹¹

Statistically, Robinhood users trade the riskiest products of any other brokerage and at the fastest pace. According to an analysis of brokerage firm filings done by research firm Alphacution for The New York Times, in the first three months of 2020, Robinhood users traded nine times as many shares per dollar in their account as E-Trade customers and forty times as many as customers of Charles Schwab. Even riskier, their analysis, visualized in Figure 8, found that Robinhood users “bought and sold 88 times as many risky options contracts as those on Schwab” because of the platforms’ much more simple options trading page.⁹²

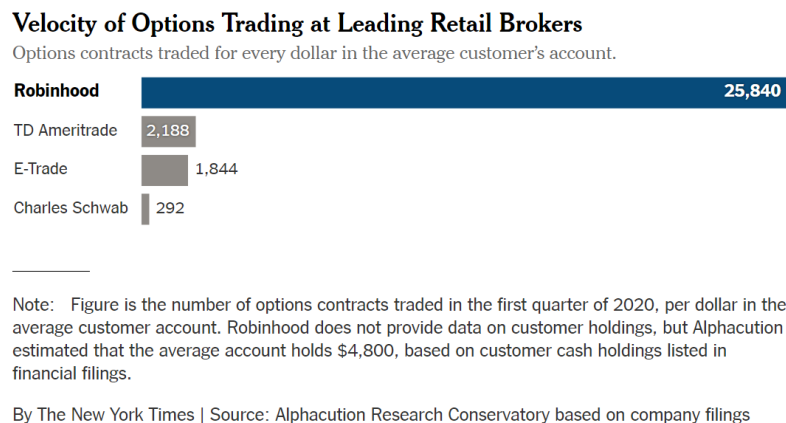


Figure 10: Popper, N. (2020, July 08). Robinhood Has Lured Young Traders, Sometimes with Devastating Results. Retrieved from <https://www.nytimes.com/2020/07/08/technology/robinhood-risky-trading.html>.

When used correctly, options can be an effective tool to reduce risks in existing investments. Typically, investors buy options to hedge direct investments by compensating for any losses that may happen to the stock underlying the option. An investor can also trade options as standalone investments, which are very risky and speculative but can potentially have higher gains or losses. When Robinhood

⁹¹ Pisani, B. (2021, February 18). Robinhood-GameStop hearing will scrutinize how brokerages get paid for trades. Retrieved from <https://www.cnbc.com/2021/02/18/payment-for-order-flow-the-controversial-wall-street-practice-to-draw-scrutiny-at-robinhood-hearing.html>

⁹² Popper, N. (2020, July 08). Robinhood Has Lured Young Traders, Sometimes With Devastating Results. Retrieved from <https://www.nytimes.com/2020/07/08/technology/robinhood-risky-trading.html>

introduced its options trading feature in December 2017, three years after they launched the platform, it was yet again revolutionary for the industry. According to their website, options trades on Robinhood have “no commission and no per contract fee upon buying or selling options, as well as no exercise or assignment fees. Currently, options traders pay up to \$6.95 + \$0.75/contract and up to \$19.99 upon exercising and assignment. As with equities, the execution of options is purely electronic, making commission fees a thing of the past.”⁹³ They also provided a comparison,

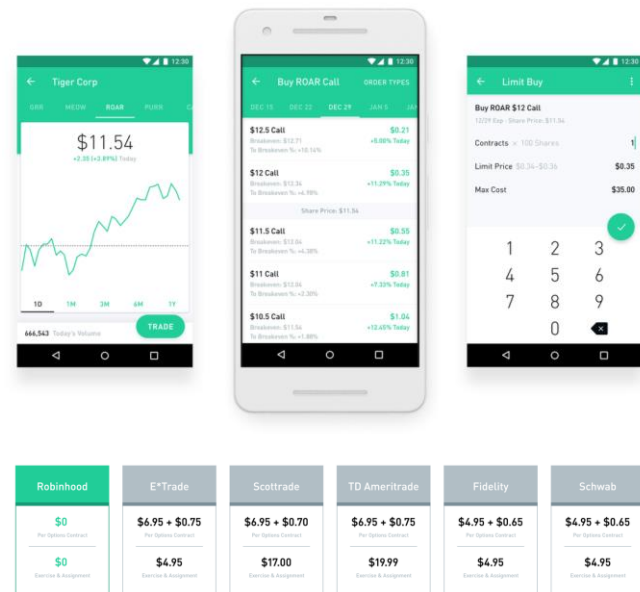


Figure 11: Screenshots of Robinhood options platform, comparison of fees with competitors

Source: Robinhood Team. (2017, December 13). Introducing Options Trading. Retrieved from <https://blog.robinhood.com/news/2017/12/12/introducing-options-trading>.

shown in Figure 9, between themselves and their competitors' fees, showing that Robinhood removed the cost barrier to options trading. Like they had done with stock trading years before, Robinhood allowed any user to become an options trader, something that had previously only been accessible to institutional or professional traders.

On Robinhood, users would be required to enable options trading, which entails a simple terms and conditions agreement, and then any Robinhood user could then trade using complicated options strategies. Options can be great if you know how to use them, and with the Internet, there is a lot of information out there on what options are and how to use them in the right ways. On top of that, not having any commissions or fees associated with trading them encourages investors to trade more options, similar to what happened with regular stock trading when Robinhood was founded.

⁹³ Robinhood Securities. (2017, December 13). Introducing Options Trading. Retrieved from <https://blog.robinhood.com/news/2017/12/12/introducing-options-trading>

In 2020, as more and more individual investors entered the market, stock options volume took off. Daily volume in options was up 68% to 17.3 million from the 10.3 million daily average in 2019. In December 2020, daily average volume hit a record for the year of 23.4 million contracts, with the volatile market heading into the end of the year.⁹⁴ In an interview on Bloomberg with Joe Mecane, head of execution services at Citadel, he outlined that his firm has seen a significant uptick in retail options and stock trading in the last few years, systematically because of zero commissions, but also because of the volatile market that has occurred. As I mentioned earlier, Citadel is the middleman for about 40% of retail trades in the market. Mecane also noted that the growing popularity of options trading reflects an increase in retail investors' knowledge and access to complex investment vehicles.⁹⁵

The core of Robinhood's business is to incentivize more trading. It does not charge fees for trading, but the company makes more money when its clients trade more through the payment for order flow scheme, which I described in the previous chapter. Payment for order flow is nothing new, and all the retail brokers like E-Trade and Charles Schwab do it. The difference is that Robinhood makes significantly more for selling their users orders than other platforms. The same analysis done by Alphacution for The New York Times showed that for each share of

stock traded, Robinhood made between four and fifteen times more than Schwab in the most recent quarter, according to the filings.

In total, they estimate that Robinhood received \$18,955 from the trading firms for every dollar in the average customer account, while Schwab made \$195, the Alphacution

Total Payments From High-Frequency Trading Firms

What retail brokers make from selling customer orders, per dollar in the the average account.



Note: Revenue in the first quarter of 2020 from all professional trading firms for every dollar in the average customer account. Unlike other firms, Robinhood does not provide data on customer holdings, but Alphacution estimated that the average account holds \$4,800, based on customer cash holdings listed in financial filings.

By The New York Times | Source: Alphacution Research Conservatory based on company filings

Figure 12: Popper, N. (2020, July 08). Robinhood Has Lured Young Traders, Sometimes with Devastating Results. Retrieved from <https://www.nytimes.com/2020/07/08/technology/robinhood-risky-trading.html>.

⁹⁴ SoFi Financial. (2021, January 08). Stock Option Volume Reached New Levels in 2020. Retrieved from <https://www.sofi.com/blog/stock-option-volume-reached-new-levels-2020/>

⁹⁵ Bloomberg News. (2020, July 9). Citadel Securities' Mecane Says Volatility Behind Rise in Retail Investing. Retrieved from <https://www.bloomberg.com/news/videos/2020-07-09/citadel-s-mecane-says-volatility-behind-rise-in-retail-investing-video>

analysis showed. According to the New York Times article, industry experts said this was most likely because the market-making firms can make the most effortless profits from Robinhood customers because the platform has the least stringent requirements for execution of the market maker.

A game or investment?

Robinhood customers are often considered ‘gamblers’ on the stock market with small amounts of money and taking huge risks because of Robinhood's young user base and access to information for all. The Internet has allowed anyone to obtain information, whether it is true or false, rapidly. With social media and generally increased collaboration through the Internet, users use platforms like Reddit, Facebook, Instagram, and Twitter to communicate and, in some cases, discuss stock picks and trade ideas. With the technologies available today, everyday investors can communicate instantly, band together on the same trade idea, and buy or sell commission-free. Trading together and in masses can drive a stock up or down even if the amounts of money being invested are relatively small. On the other hand, professional traders are heavily restricted from colluding with other traders and have much higher costs than the average retail trader nowadays.⁹⁶

Robinhood generally appeals to a younger generation of investors, with its simple design, little capital commitment, and unlimited free trades. As of January 2015, their user base was exactly reflecting their target market. 80% of users were millennials, the average age was 26, and most importantly, a quarter of their user base was first-time investors. By February 2018, the platform had grown to have 3 million active accounts, about the same as traditional broker E-Trade, and was expanding rapidly with demand.⁹⁷ As of late 2020, Robinhood had more than 16 million users.

Robinhood releases data on the number of accounts that own each stock, and that data is uploaded and aggregated several times a day. In early 2020 as COVID-19 began to spread across the globe, triggering

⁹⁶ Zweig, J. (2021, January 30). The Real Force Driving the GameStop Revolution. Retrieved from <https://www.wsj.com/articles/the-real-force-driving-the-gamestop-amc-blackberry-revolution-11611965586>

⁹⁷ RobinTracks

lockdowns, Robinhood added 3 million new accounts in the first four months of the year, and there was a significant increase in Robinhood customers' holdings in airlines, cruise ships, and other risky sectors during a pandemic.

BCA Research, a financial research firm, published a report in June of 2020, analyzing the available Robinhood data. They found that Robinhood users were essentially betting that the pandemic would not destroy airlines and cruise lines and were hoping for recovery or bailout by the government. As of the BCA article's publishing date, the number of Robinhood accounts holding six US airline stocks had risen 48 times year to date, with United up the highest at 87 times. The same is valid for cruise lines and other seriously affected industries whose share prices have collapsed, with investors looking for deep value to hold on to in the hope that they can hold off bankruptcy until the pandemic is over. There are potentially sizable returns to be had if they can emerge mostly unscathed, but that is a big if.

When the Coronavirus pandemic swept the globe in early 2020, one of the first things that had to be canceled was sports seasons. The NBA's 2019-20 season was canceled on March 11th. The pandemic forced millions of people worldwide to quarantine at home, and with sports not on the TV, all the sports betters had nothing to bet on. An article in the New York Times describes a man named Stephen Young, who was previously an avid sport-better. After the Coronavirus canceled most seasons, he withdrew all his money from his sportsbook accounts and deposited it into Robinhood to invest in the stock market instead.⁹⁸ When his federal stimulus check arrived, he put the money from that in too. Mr. Young was just one of the three million new accounts in the first half of 2020. While we can never know how many sports betters specifically moved directly into stock trading, many of them acted like aggressive gamblers, making high-risk options trades through their phones. On top of that, a significant number of trades that made little sense were happening, like buying up the nearly valueless shares of bankrupt companies, as exemplified when car-rental company Hertz filed for bankruptcy.

⁹⁸ Phillips, M. (2020, June 14). Trading Sportsbooks for Brokerages, Bored Bettors Wager on Stocks. Retrieved from <https://www.nytimes.com/2020/06/14/business/sports-gamblers-stocks-virus.html>

When a company goes bankrupt, it does not have enough assets to meet its debt obligations. Since debt is a 'senior' claim, the equity shareholders in the stock of a company would see their investment's value disappear if they had to go through bankruptcy. Amid the coronavirus pandemic, shelter-in-place orders and a travel ban severely impacted Hertz's business and many others in the travel sector. As all travel became impossible, their rental cars were sitting in airport parking lots across the country while they still had to make interest and insurance payments on an auto fleet of 667,000 cars. To keep the company afloat, they furloughed employees, slashed spending, and sold assets. Unfortunately, none of it was enough, and the company filed for bankruptcy on May 22nd, 2020, sending the share price very close to \$0/share. One of the largest shareholders at the time was billionaire investor Carl Icahn, who sold his 55.3 million shares in Hertz after the bankruptcy filing, taking a \$1.8 billion loss. Filing for bankruptcy does not mean that a company must go out of business immediately. Chapter 11 bankruptcy allows the management of a company time to renegotiate the debt liabilities to see if there is any chance of being able to restructure. Generally, once a company is restructuring debt, equity owners' value gets eliminated.

While on May 22nd, the day of the bankruptcy announcement, shares were down significantly. Between May 26th and June 8th, Hertz shares rallied from \$0.56 to \$5.53, a 900% gain. According to RobinTrack, the website that shares public Robinhood holding data, nearly 43,000 Robinhood accounts held Hertz before their bankruptcy filing. By the first week of June, it was 73,000 and peaked at 171,000 by mid-June, a staggering increase in a short timeframe. In a last-ditch effort, the company issued \$500m in more stock to take advantage of the volatile and unusually high share price. In the filing, they warned potential buyers that it is almost certain it will become worthless unless there is a significant turnaround in travel and COVID-19.⁹⁹ The company was essentially issuing stock with the expectation that they would almost certainly be valueless soon, making buying the shares a complete gamble. Despite the warnings, Robinhood users held firm, and there were 137,050 Robinhood users still holding Hertz stock when

⁹⁹ Franck, T. (2020, June 15). Hertz says it expects stockholders to lose all their money in filing for selling more stock. Retrieved from <https://www.cnbc.com/2020/06/15/hertz-says-it-expects-stockholders-to-lose-all-their-money-in-filing-for-selling-more-stock.html>

Robinhood decided to stop sharing the public data on August 13th. The company delisted from the NYSE on October 29th.¹⁰⁰ While Hertz still trades on secondary markets, it is essentially valueless, and all those Robinhood users who held the stock now hold completely worthless equity. This investment decision would not maximize value whatsoever for those that chose to invest.

The reason people bought shares in Hertz because they saw a brand they knew and liked and believed that the company was worth more than the pennies it was trading for at the time. As a result of many investors feeling the same sentiments, the stock price rose. That logic is irrational and indicates that the buyers did not fully understand that the shares could and probably would fall to zero and leave them with a total loss.¹⁰¹ While it is still up for debate how much Robinhood investors affect the stock market, it certainly is true that many traders can swing markets. Even with modest amounts of money invested in large numbers, Robinhood traders can heavily affect share prices, which are usually set by a handful of highly wealthy shareholders or money managers. Buyers and sellers set prices, and generally, most shareholders do nothing on a given day. Therefore, a spike in trading activity from thousands of Robinhood traders can indeed move share prices.

In the case of GameStop in early 2021, Reddit played a massive part in the events that transpired and allowed individuals to influence others' trading decisions via posts on the r/WallStreetBets page. Many people felt so passionate about investing in GameStop and others because they thought the hedge funds that were shorting those companies were 'bad actors' and had a role in the financial crisis of 2007-2008. The hedge fund that was at the center of the whole GameStop short squeeze was Melvin Capital Management, a multi-billion-dollar fund, founded by ex Point72 portfolio manager Gabe Plotkin in 2014 with a focus on short positions. Melvin had a good track record, with annualized returns of 30% between 2014 and 2020.

¹⁰⁰ Robintrack.net; Roberts, J. J. (2020, August 10). Robinhood will no longer share stock 'popularity data' with sites like Robintrack. Retrieved from <https://fortune.com/2020/08/10/robinhood-popularity-data-robintrack-stock-market-trading-tracker/>; The New York Stock Exchange. (2020, October 29). NYSE Announces Decision to Suspend and Remove Hertz Global Holdings, Inc. (HTZ) From the List. Retrieved from <https://ir.theice.com/press/news-details/2020/NYSE-Announces-Decision-to-Suspend-and-Remove-Hertz-Global-Holdings-Inc.-HTZ-From-the-List/default.aspx>

¹⁰¹ Smith, K. A. (2021, March 03). Robinhood & Hertz: The Troubling Saga Of A Bankrupt Stock. Retrieved from <https://www.forbes.com/advisor/investing/robinhood-bankrupt-hertz/>

However, in early 2021, their short positions in GameStop and other heavily shorted names became the retail investors' target on Reddit.¹⁰² The goal of those online was to squeeze hedge funds' short positions by buying the stock and options that would cause the share price to rise and cause hedge funds to lose large sums of money. In the first three months of 2021, it was reported that Melvin Capital lost 49% on its investments because of the short squeeze, demonstrating the power of retail investors banding together online.¹⁰³ Simultaneously, some newspapers reported that institutional investors were also jumping on the social media hype at the same time, and many hedge funds traded in the same way that retail investors did, riding the bubble.¹⁰⁴

On top of the social media involvement, Robinhood as an app is geared towards simplicity for its users, not always in a positive light, however. Firstly, users of Robinhood will describe prominently seeing a list of "Top Stocks," free of any other information other than they are popular with their users. They also have much less information available for users. Robinhood provides five charting indicators, while TD Ameritrade provides 489. The lack of copious amounts of information simplifies the process of looking for a solid investment, but also restricts users to only the information that Robinhood deems relevant to their general user base.¹⁰⁵ On top of that, buying a stock is extremely easy, and once a trade has been placed, there are animations of confetti celebrating the investment, and potentially encouraging them to be celebrated again by placing another trade.

After extensive research on the topic, professors of behavioral finance Brad Barber and Terrance Odean at the University of California at Davis argue that investors that use Robinhood are more likely to

¹⁰² Chung, J. (2021, January 31). WSJ News Exclusive | Melvin Capital Lost 53% in January, Hurt by GameStop and Other Bets. Retrieved from <https://www.wsj.com/articles/melvin-capital-lost-53-in-january-hurt-by-gamestop-and-other-bets-11612103117>

¹⁰³ Reuters News. (2021, April 09). Hedge fund Melvin Capital lost 49% on its investments in Q1 -source. Retrieved from <https://www.reuters.com/article/us-hedgefunds-melvin/hedge-fund-melvin-capital-lost-49-on-its-investments-in-q1-source-idUSKBN2BW2Q2>

¹⁰⁴ Pedersen, L. H. (2021, March 01). Game On: Social Networks and Markets. Retrieved from <https://ssrn.com/abstract=3794616>. Page 33

¹⁰⁵ Barber, Brad M. and Huang, Xing and Odean, Terrance and Schwarz, Christopher, Attention Induced Trading and Returns: Evidence from Robinhood Users (February 2, 2021). Available at SSRN: <https://ssrn.com/abstract=3715077> or <http://dx.doi.org/10.2139/ssrn.3715077>

be influenced by others than those using other platforms.¹⁰⁶ They have studied the retail investing phenomenon since the early 2000s, and in a 2008 study they published “*All that Glitters: The Effect of Attention and News on the Buying Behavior of Individual and Institutional Investors*,” which found that individual investors, on average, lose money from trading, and that limited attention prevents many retail investors from considering all the options and information out there. Instead, many investors choose to invest in stocks that catch their eye in the news, or on their brokerage platform, causing them to not always make the best investment decision.¹⁰⁷ On top of that, since most retail investors don’t have the ability to short or know how to, they only look for investments that will appreciate, which certainly is not the case all the time and could result in losing money.

In a study Barber and Odean published in November 2020, they state that “Robinhood’s app is simple and engaging, designed to encourage people to invest. Robinhood added features to make investing more like a game. New members were given a free share of stock, but only after they scratched off images that looked like a lottery ticket.” The ‘gamification’ of stock trading on Robinhood, along with the fact that half of Robinhood users are first-time investors who are unlikely to have developed their own investing strategy, causes investors to make unsound investment decisions based on social sentiment rather than true analysis and a belief in a stock being undervalued.

For institutional investors, technology and the Internet have changed how they operate as well. As I described earlier in this paper, computing allowed hedge funds to trade much faster once electronic trading systems were in place and working. Michael Lewis's *Flash Boys* is one of the most famous stories of electronic trading, which turned into high-frequency trading. The book is essentially the story of how investors were looking for the fastest data link possible to trade faster than their competitors and how they went about doing it.

¹⁰⁶ Barber, B. M., Huang, X., Odean, T., & Schwarz, C. (2020, October 23). Attention Induced Trading and Returns: Evidence from Robinhood Users. Retrieved from https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3715077

¹⁰⁷ Barber, B. M., & Odean, T. (2007, December 24). *All That Glitters: The Effect of Attention and News on the Buying Behavior of Individual and Institutional Investors*. Retrieved from <https://doi.org/10.1093/rfs/hhm079>

When it comes to trading as quickly as possible, it is all about where you are located physically because of the Internet's delay over distances. When trading large sums of money, a few millisecond delays could cause a very significant gain or loss in volatile markets. Fiber cables have a maximum speed over a certain distance. To work around the speed problem, many banks and financial institutions constructed data centers in New Jersey, just over the Hudson River from Manhattan, where they all had their offices.¹⁰⁸ By putting the servers near their offices, they would minimize the delay as much as possible and maximize the likelihood that their trade would execute faster than the price moves. The ability to trade so rapidly has also led institutional investors to change their game. Before computers were as commonplace in the stock market as they are today, professional investors typically solely looked for companies with growth potential and whose share price would rise. However, there is certainly a market for professional investors who use the speed benefit of technology to their advantage to make a profit.

Chapter 7: Crashes and consequences

Generally, the technologization of finance and investing has been a positive change for investors. Beginning in the 1980s, when computers were first introduced to the world and applied to the markets, trading was restricted to those who could afford the steep commissions. It was also considerably slower and done mainly by phone, which allowed for human error and significant delays, leading to buying or selling something at an inaccurate price. With computerized trading systems connected to the Internet, trading has become much faster and more specific and can be done by anyone from anywhere. While technology in the stock market has had a positive impact overall, there are certainly downsides and risks associated with moving to a computer-based system and removing the human from most of the equation of stock trading.

¹⁰⁸ Roodman, J. (2020, March 20). The Technology Behind High-Frequency Trading. Retrieved from <https://sabeydatacenters.com/blog/technology-behind-high-frequency-trading/>.

A movie scene that comes to mind when thinking of a downside of technology in finance is a scene from *The Dark Knight Rises*, a Batman movie that was released in 2012.¹⁰⁹ The scene involves Batman's nemesis, Bane, who attacks and holds the Gotham Stock Exchange (modeled after the NYSE) hostage. Bane and his armed accomplices force a trader to unlock his terminal and trick biometric authentication systems into allowing him to trade on behalf of Batman and his company, Wayne Enterprises. After breaking into the stock exchange and bypassing security, Bane bets all of Batman's stock in Wayne Enterprises on "futures" or options that would end up worthless, causing him to lose everything.

While the idea of breaking into a stock exchange and trading on behalf of someone could in fact be possible, it is extremely unlikely as the exchange would likely shut down before any trades can be executed, not to mention the trail of records that would be left behind. The whole scene is depicted similarly to a bank heist, but the difference is that there is physical cash to steal at a bank, whereas at a stock exchange, there is nothing but computers. Despite all that, the prospect of a computer hack disrupting a financial market is a very real one. While there have not been any large hacks that have disrupted the markets significantly so far, there is certainly the possibility for one happening if security is not maintained as a top priority.

For years, cybercrime has been known to be one of the most significant threats to the financial services industry as computers and technology become more involved in every aspect of a business. Massive hacks like at Equifax in 2017 show how massive corporations can often be the target of multiple sophisticated cyber-attacks. According to an SEC report released in February 2015, 88% of brokerages and 74% of advisors in the US have faced cyberattacks.¹¹⁰ Even more shocking, testimony from a Congressional hearing on the topic in June of 2015 shows that a major bank in the US is attacked virtually every 34 seconds.¹¹¹ Nowadays, most companies and organizations have invested serious capital in boosting their

¹⁰⁹ *The Dark Knight Rises*. (2012, July 19). Retrieved from <https://www.imdb.com/title/tt1345836/>.

¹¹⁰ SEC. Cybersecurity Examination Sweep Summary. (2015, February 3). Retrieved from <https://www.sec.gov/about/offices/ocie/cybersecurity-examination-sweep-summary.pdf>

¹¹¹ Anand, P. (2015, July 31). How vulnerable are the U.S. stock markets to hackers? Retrieved from <https://www.marketwatch.com/story/how-vulnerable-are-the-us-stock-markets-to-hackers-2015-07-31>.

security to fend off most serious attacks or limit their impact. On top of that, there are also redundancies built into the market that would help if an exchange went offline. Many shares, while they may be listed on one exchange, can be traded on others too. So, if the NASDAQ went down, the NYSE would allow people to trade NASDAQ listed stock on their exchange, keeping the market open. However, if multiple exchanges went down, that would prevent people from trading and would likely cause widespread panic throughout the world.¹¹² The threat of a cyberattack is being taken very seriously by the US government, which has tasked the Defense Advanced Research Projects Agency (DARPA), which oversees the development of advanced technologies for use by the US military, identifying weaknesses in the American financial system. One could argue that a cyberattack and computer outage is among the few non-physical attacks that would paralyze our economy and way of life more than a pandemic.

Policy changes to account for technology

As I discussed in Chapter 2, high-frequency trading was first seen as a trading technique in 1999, but the ‘flash crash’ of 2010 sparked the discussion of how the market can be protected from significant increases or decreases in the market, for any reason. Through the investigation that followed, it was later revealed that a massive electronic trade executed by a mutual fund by accident triggered the reaction and massive confusion in the market.

While the ‘flash crash’ was unprecedented because of how the market collapsed and then immediately bounced back, the first instance of rapid market moves caused by technology was in 1987, when computers were first introduced to the financial markets. On October 19, 1987, the Dow Jones lost almost 22% in a single day, marking the beginning of a months-long stock market decline. That day was known as ‘Black Monday.’ In the wake of Black Monday, regulators created so-called ‘circuit breakers’, that would pause trading temporarily in times of sharp declines or rises to protect investors in a volatile market.

¹¹² Wilson, C. (2018, May 03). Yes, a Stock Market Hack Can Happen - Here's How. Retrieved from <https://moneymorning.com/2017/07/05/yes-a-stock-market-hack-can-happen-heres-how/>.

Two decades after Black Monday, after the congressional hearings following the ‘flash crash’ of 2010, the SEC approved new rules for those circuit breakers that were more applicable to electronic trading capabilities. The circuit breakers will stop trading of a stock or index for five minutes if the price moves by 10 percent or more in a five-minute period to prevent more significant moves that a computer issue could trigger.¹¹³ When COVID-19 placed much of the globe under lockdown in March 2020, markets tanked due to the uncertainty, triggering circuit breakers that helped prevent a more severe market decline. Some of the share prices of companies in industries that were hit hardest by the pandemic tanked. On the most volatile days in March, halts happened hundreds of times to stocks such as Carnival Cruise Lines or Delta Airlines. An investor may be frustrated with the pause if they are trying to trade the stock now and cannot.¹¹⁴ On the other hand, it can be more reasonably argued that the trading halts lessened the volatility during a time of absolute uncertainty in the world and market and served their purpose. With the way that markets move now due to technologies that allow instant trading, circuit breakers have provided a buffer to increasingly unpredictable markets.

The Knight Capital Trading Glitch

On August 1st, 2012, Knight Capital, a major retail market maker at the time, experienced a trading glitch on one of their servers that handled automated order routing. Before the glitch, they were a revenue-producing business, bringing in around \$1 billion in revenue. In fact, in the first half of 2012, Knight had annualized revenues of about \$1 billion and \$250m in pre-tax profit. They had great client relationships and strong order flow, allowing them to be successful through trading technologies.

As I mentioned in the introduction, Mr. Joyce, CEO of Knight Capital at the time was at home recovering from a knee operation when he received a phone call from his head of trading informing him of

¹¹³ Wyatt, E., & Bowley, G. (2010, May 18). New Rules Would Limit Trades in Volatile Market. Retrieved from <https://www.nytimes.com/2010/05/19/business/19crash.html?hp>.

¹¹⁴ Osipovich, A. (2020, May 05). Post-Flash Crash Fixes Bolstered Markets During Coronavirus Selloff. Retrieved from <https://www.wsj.com/articles/post-flash-crash-fixes-bolstered-markets-during-coronavirus-selloff-11588671000>.

the situation. When the market opened at 9:30 am on Wednesday, August 1st, one of Knight's servers ran defective code that executed a total of 4 million trades for more than 154 stocks, 397 million shares in all, before the technology team at Knight pulled the plug on the server. By the time Knight stopped sending the orders, Knight had assumed a net long position in 80 stocks of approximately \$3.5 billion and a net short position in 74 stocks of approximately \$3.15 billion.¹¹⁵ Ultimately, Knight had to write off the unwanted positions and lost over \$460 million.¹¹⁶

Before the glitch, the company had about \$450 million in cash on its balance sheet. When the glitch happened, Mr. Joyce had to do damage control to save the company from going bankrupt. He spent the next couple of days trying to find investors to back Knight and put up more money. By August 5th, Knight had raised \$400 million from investors to stay in business after the trading error. In the process, they issued more shares at a meager price, wiping out most of the shareholder value, including the shares of many employees. Despite that, Knight was still in business but was not left unscathed.

The story shows how quickly an error in an algorithmic trading program can affect a company and the market so dramatically. The trades were all in error, but Knight had to take the losses on all the trades because of laws surrounding dealing with errors. As a result, the company came very close to bankruptcy.

The downsides of retail investing

From the last decade of the 20th century to today, American households have become more exposed to the stock market. According to research published by Edward N. Wolff, an economist at New York University, the percentage of stock ownership in US households rose significantly with the success of personal brokerage accounts and the Internet. In the 1980s and 1990s, there was a move toward democratizing stock ownership with the advent of individual retirement and brokerage accounts. However, the financial crises of 2001 and 2007 put off some middle-class investors, as you can see shown in Figure

¹¹⁵ Interview with Tom Joyce

¹¹⁶ SEC. Findings in the matter of Knight Capital Americas LLC. (2013, October 2013). Retrieved from <https://www.sec.gov/litigation/admin/2013/34-70694.pdf>

11. As of 2016, 84 percent of all stocks owned by Americans, including mutual funds and pensions, belong to the wealthiest 10 percent of households, reflecting the country's wealth disparity.¹¹⁷

The stock market has always been at its core investing for individuals. However, until recently, many people were more exposed to the stock market through retirement funds and less through investing in individual companies. With the Internet and brokerages being accessible to anyone, more people have returned to investing in single stock names, which are inherently riskier than

a diversified investment fund before, but that was all that was possible at the time for those that were not extremely wealthy.

Apps like Robinhood market themselves as ‘democratizing finance’ for everyone, and that is certainly true in the sense that it allowed anyone access to a previously cost-prohibitive trade. Robinhood is the prime example because it made trading stocks and options completely free, which was typically expensive and only the wealthy could afford to do regularly. On top of that, with every question a Google search away nowadays, regular people can read the same up-to-date news for free that was previously a costly resource. While it may sound like Robinhood has only had a positive impact on the way people trade stock, it is primarily true. A new company has disrupted how the brokerage business has always been done, which comes with positive and negative effects.

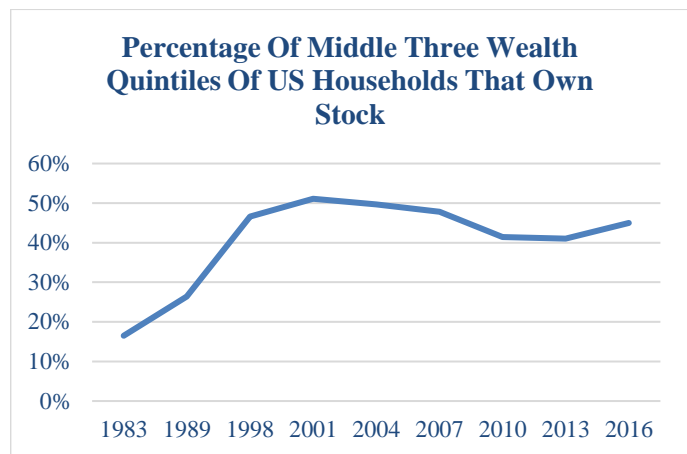


Figure 13: Wolff, E. (2017). *Household Wealth Trends in the United States, 1962 to 2016: Has Middle Class Wealth Recovered?* NBER Working Paper Series. doi:10.3386/w24085

¹¹⁷ Cohen, P. (2018, February 08). We All Have a Stake in the Stock Market, Right? Guess Again. Retrieved from <https://www.nytimes.com/2018/02/08/business/economy/stocks-economy.html>.

Mind games

Robinhood's options trading function allows any Robinhood user to trade complex option strategies in a simple user interface in their app. All any Robinhood user would have to do is accept an agreement, and then they would be free to trade options, something that had historically only been accessible and done by professionals. While options, in theory, can reduce the risk for investors, they can result in significant losses when executed incorrectly. In June 2020, the worst possible scenario happened, a 20-year-old Robinhood client named Alex Kearns tragically took his life after a glitch on Robinhood's app led him to think that he had lost \$750,000 in an options trade. His last known written words were, "How was a 20-year-old with no income able to get assigned almost \$1 million worth of leverage?" After writing that letter, Alex rode his bike down to a railroad crossing and jumped in front of a train. Since his death, his parents have filed a lawsuit against Robinhood for wrongful death, which revealed more information about the situation and what exactly happened.¹¹⁸

Alex was a college student, sent home by the COVID-19 pandemic at the time, and had signed up for Robinhood his senior year of high school to invest \$5,000 he had saved. By the time he was a freshman in college, he had just under \$20,000 in his account and was quickly authorized for Level 3 "advanced" options trading on Robinhood. Meaning he could trade sophisticated options spreads, which involve buying multiple options in tandem.¹¹⁹

According to the lawsuit his parents filed, "Alex had placed an option spread trade whereby he simultaneously acquired and sold put options in the same security, in theory limiting his risk, but actually containing a risk Alex did not understand, which was the risk that the put options he had sold could be [exercised] before expiration, which resulted in his being obligated to purchase the underlying security at the strike price of the options, before he was able to sell the options he owned." Because of the options

¹¹⁸ Dan Kearns vs Robinhood Financial (Superior Court Of The State Of California For The County Of Santa Clara, February, 2021). Retrieved from <https://www.courthousenews.com/wp-content/uploads/2021/02/robinhood-1.pdf>

¹¹⁹ Advanced Options Strategies (Level 3). (n.d.). Retrieved from [https://robinhood.com/us/en/support/articles/advanced-options-strategies /](https://robinhood.com/us/en/support/articles/advanced-options-strategies/)

structure, on June 11th, 2020, Alex was obligated to buy the underlying stock during the trading day. “Alex did not learn this until later, when his account reflected a negative cash balance in his account of \$730,000, which was more than \$700,000 greater than the amount of cash he had in the world.” Figure 12 is a screenshot from Alex’s Robinhood account that night, provided by his family. The huge number did not make sense to Alex, and made him “extremely concerned and upset.” To add fuel to the fire, at 11:01 pm that same night, Robinhood emailed Alex saying that his account was restricted, adding to his worries. What he knew at the time was that he had somehow lost \$730,000 on a trade that he thought had a maximum loss of less than \$10,000, a massive difference. He emailed Robinhood, but since they have no call centers, he received an automated response notifying him that the response would be longer than usual, not helpful at all to Alex, who was extremely worried he had lost a vast amount of money.

Things only got worse from there. At 3:26 am, Alex received an automated email from Robinhood with the subject line “Immediate Action Required: Reg T Call Due.” According to the lawsuit, the email said he “was required to deposit \$178,612.73 by June 17, 2020.” They also go on to reveal that “Alex’s account had held only about \$16,000 before Robinhood allowed him to trade the put spread, which controlled hundreds of thousands of dollars worth of securities.” He sent two more emails to Robinhood on June 12th, to no avail. He wrote, “I was incorrectly assigned more money than I should have, my bought puts should have covered the puts I sold. Could someone please look into this?” He thought that he had been assigned leverage and had just used it and lost it instead of a short technological glitch that would be resolved soon. Perhaps because of his lack of experience with how options settle, Alex believed that his family would somehow have to pay for his losses. The stress was

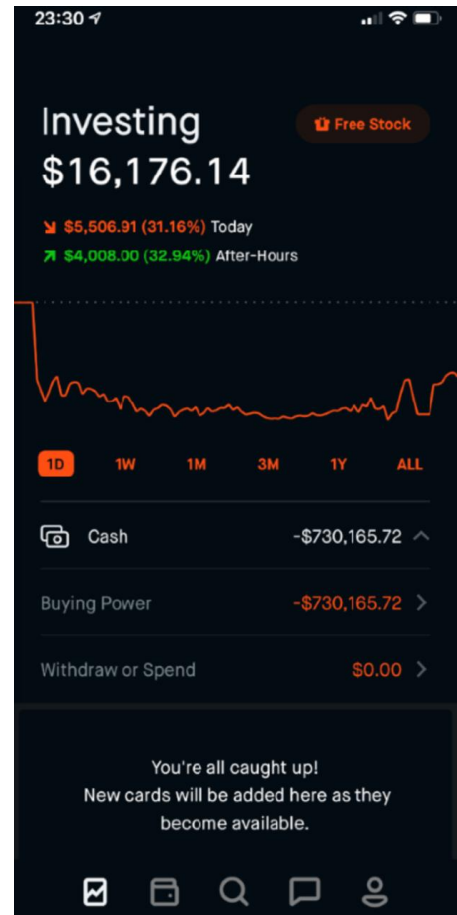


Figure 14: Screenshot of Alex Kearns’ Robinhood account, showing a negative balance of \$730k.

Source: Dan and Dorothy Kearns via CBS News

mounting for him, and with no answers from Robinhood, Alex sadly felt he had no choice but to take his life.

The worst part of the whole story is that the day after Alex jumped in front of that train, Robinhood sent him an automated email saying, “Great news! We are reaching out to confirm that you've met your margin call, and we've lifted your trade restrictions. If you have any questions about your margin call, please feel free to reach out. We're happy to help!”¹²⁰ The trade had settled, but it was too late. Alex was gone, and he had not lost any money at all. A simple glitch in the system and a lack of customer support led to a young man taking his life, and Robinhood really should learn from that. Other brokerage platforms have 24/7 phone line customer support for a reason. While Robinhood cuts down on staff to have zero-commission trading, they still need to ensure that customers have someone to talk to about their money.

The case that the Kearns family has against Robinhood is a valid one, in my opinion. They put it nicely, saying, “Robinhood uses aggressive tactics and strategy to lure inexperienced and unsophisticated investors, including Alex, to take big risks with the lure of tantalizing profits.” He had no money to satisfy the margin call, and he had no one to contact who could explain what was going on. A technological glitch, combined with aggressive marketing towards younger people and a complete lack of customer service, led to Alex taking his life. While Robinhood’s mission is to “democratize finance,” they typically target younger and inexperienced investors, allow them to engage in dicey trading practices like options trading, and then provide no customer support when it is most needed, all while profiting on their order flow.

Robinhood advertises itself with its mission to bring younger and more diverse investors into the market. On the flip side, trading on the stock market can be a risky business without any prior education. They ran a marketing campaign called “we are all investors,” where Robinhood says that “we are all investors” and “you don’t need to become an investor; you were born one.” Their slogans directly market their platform to their audience of anyone, a shift from a traditionally closed-off brokerage and wealth

¹²⁰ Tony Dokoupil, M. K. (2021, February 08). Alex Kearns died thinking he owed hundreds of thousands for stock market losses on Robinhood. His parents have sued over his suicide. Retrieved from <https://www.cbsnews.com/news/alex-kearns-robinhood-trader-suicide-wrongful-death-suit/>.

management industry to only those with significant portfolios. Creating this image that everyone is an investor can lead people to believe that they understand something that is very complicated and could be out of their control. In the case of Robinhood, when inexperienced investors trade risky options, it can end badly for those investors, which can have more significant consequences, as we saw in the devastating case of Alex Kearns. Robinhood has since responded, saying that just 12% of their customers' trade options, and fewer than 1% place multi-leg options on a monthly basis.¹²¹ Despite that, 1% of an estimated 20 million users is 200,000 people, many people who may not be those who have a lot to lose, unlike professional traders. On top of that, Robinhood has since done very little to prevent a similar situation from happening again retroactively, and the Kearns lawsuit is still ongoing as of writing this. The company has since launched phone support for issues relating to options trading and other problems customers may have.

Chapter 8: Going forward and the future:

In the last decade, retail brokerages have eliminated the costs associated with trading while still providing investors with the same service they always provided, trading stocks without upfront costs, account minimums, or commissions. The lack of a cost barrier is drawing more people into a growing market of new and generally younger individual investors who want to invest for their future. We got to this point through the Internet, and without it, none of this would have been possible. The first brokerage, E-Trade, made it possible to trade through the Internet in 1992 and became popular instantly because it allowed ordinary people to get in on electronic trading. Since then, online investing has flourished to the point where almost all trades are made electronically currently, and anyone can transfer money into a brokerage account and enter the market.

Historically, individuals have invested in the stock market through retirement accounts through their employer or with the money and knowledge to invest themselves. With online brokerage platforms,

¹²¹ Robinhood Securities, (August 7, 2020), Letter from Robinhood Securities lawyers to Congress, Retrieved from <https://s.wsj.net/public/resources/documents/RobinhoodReplyToCongress.pdf>. Page 2.

traditional barriers to entry like not knowing how to set up an account, not being able to access an investment professional, and the perception that you need lots of money to trade have been eased.

As a result of the new, cost-free trading platforms available to anyone with an Internet connection, millions of people were in the game, peaking in 2020, with a record number of Americans opening taxable investment accounts. The lockdowns caused by the pandemic brought people online and with their money. Simultaneously, between January 1 and March 31, the S&P 500 plummeted by more than 20%. During the panic, many new investors saw a once-in-a-lifetime buying opportunity and now could invest with no concern about paying fees to do so. Apps like Robinhood facilitated them to enter the stock market and easily and intuitively begin trading stock in companies. A FINRA/University of Chicago report released in February 2021 detailed the results of a survey about new investors in 2020. They found that those that opened brokerage accounts in 2020 were younger, had lower incomes, and were more racially diverse than those with existing brokerage accounts before the pandemic.¹²² Their survey shows that more people are getting into the market, and the pandemic only spurred them on.

The ease of access has also come with downsides. With new investors entering the market with no experience, there is undoubtedly a need for education. Younger people have been known to be generally more risk-happy, and with stocks being free to trade, it is easy to get in and out of positions, but those trades still come with risk, which investors need to understand. Learning from prior experiences, platforms like Robinhood have said they are developing their resources to educate investors on the dangers of investing and provide them with the information needed to be successful. There are also great websites, such as Investopedia, which has definitions for many technical finance terms that may not be obvious to all users. With all the information available, though, it is easy for young people to believe that they are better informed, opening themselves up to the risk of chasing fads and trying to time the market, which is generally

¹²² FINRA Foundation. (2021, February). Investing 2020: New Accounts and the People Who Opened Them. Retrieved from https://www.finrafoundation.org/sites/finrafoundation/files/investing-2020-new-accounts-and-the-people-who-opened-them_1_0.pdf

a loss-making effort. Generally, it is easier than ever for someone to enter the market completely unprepared.

On CNBC's Half-Time Report on January 27th, 2021, Chamath Palihapitiya, social media star and founder and CEO of Social Capital, said that "the retail phenomenon is here to stay." While not everything Palihapitiya says is always correct, he is undoubtedly right about that. The investors that entered the market in 2020 are also likely not only one-time traders, and once their accounts are open, they are probably going to continue investing and trading. Bringing new people into the market also brings different perspectives and opinions on what to invest in, which moves markets. It also brings in new capital, bringing younger investors into the market is monetizing a new client base. Aided by platforms like Robinhood, people are getting into investing earlier than ever before and have the potential to increase their wealth by investing intelligently and responsibly. Going forward, only more and more people will begin investing because their friends are and because it has become exceedingly straightforward.

On top of that, with social networks such as Reddit, people can communicate amongst one another, sharing ideas and information. As we saw with GameStop, users of the r/WallStreetBets page took control of the company's stock, drove it up, sought a profit, and proved the short sellers wrong. If one thing came out of the GameStop debacle, it proved that retail investors do have control. The combination of online, free trading, and social media is one that the masses can undoubtedly manipulate markets. It is not unreasonable to believe that events like what happened with GameStop can occur again, and they probably will. We are living in the future in terms of online trading, and the only thing that could affect the market significantly would be regulation at this point.

The brokerage firms themselves have also had to adapt to a new, younger client base and have been forced to evolve to meet the demands of Millennials and Generation Z. As an example, start-up brokerage firm SoFi offers "free career counseling plus loan discounts with a qualifying deposit," directly targeting college or high school students to invest with them. Brokerages have brought a new generation of investors into the stock market since they became zero-cost and app-based. Robinhood's technical issues, and the

controversy that stemmed from their mismanagement of the GameStop stock surge, the market is open for new brokerage firms to enter the market and further evolve the retail investing market.

Artificial intelligence (AI) or machine learning has become an important and relevant topic in the last few years. Many predict that it will replace even more jobs in the future. AI is the science of creating computer programs that can understand or mimic human intelligence. The finance industry typically must process high volumes of data, keep accurate historical records, and is generally very data-heavy. As a result, finance is very well suited for AI involvement. Going forward, artificial intelligence financial advisors can manage our finances in the best way possible, with possible downsides of their own.

Overall, the impact that technology has had on the financial industry has drastically changed how people interact with the markets. Going forward, more people will continue to take advantage of being able to invest around the globe at zero cost and put some of their disposable income or savings behind a company they believe in. A survey done by Statista in May 2019 of whether people were familiar with online trading platforms showed

that 50% of respondents were not familiar with them, inferring that there is a vast untapped market that apps like Robinhood are now taking advantage of. Technology has democratized finance to its core, and the more people make the most of the resources available to them, the more prosperous they all can be.

Conclusion:

In 2020, we were entirely reliant on the Internet and telecommunications to connect to the outside world during the COVID-19 pandemic. At present, video calling and sharing technology have come so far

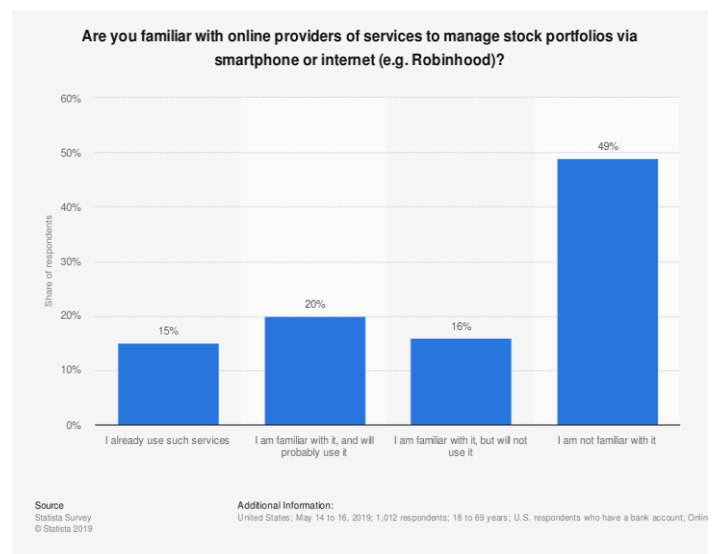


Figure 15: Results of a Statista survey on familiarity with online stock trading platforms

almost to replicate the workplace, classroom, or dining room table. The same goes for the television and the telephone, two significant inventions that have allowed people to stay entertained and productive while at a distance. Most people with reliable access to the Internet have been able to continue their work or studies remotely, which speaks to the importance of telecommunications. Life can continue despite not being together, and every invention along the way has contributed to where we are today.

During lockdowns, people used the resources available to them to take advantage of one of the fastest stock market declines in years and make money. Millions of people are now trading on the stock market earlier than ever before, including many that never would have signed up for a traditional brokerage that is complicated to navigate and has fees. Robinhood revolutionized the industry because it made trading free and straightforward to use for everyone. On top of that, they aggressively market themselves as “trading for all” and that “anyone can be an investor.”

An explosion in access represents the Information Age and availability of information through telecommunications inventions, peaking with the Internet. Information is now not bound by the physical restrictions of printed texts or where someone is in the world. At present, the Internet is a crucial resource to much of the human population. The Internet has also evolved with our needs. It is no longer just the home of email, static web pages, and discussion boards. Today’s Internet is so much more. It is a dynamic space for collaboration, commerce, and expression. The Internet has changed political systems, revolutionized business, and reshaped communities worldwide. It is not known as the knowledge age because of our tendency to just ‘Google’ everything and not retain knowledge. While the process of democratizing knowledge took more than 500 years from the invention of the printing press to now, people now can access any materials they need through the Internet.

Technology has transformed almost every aspect of the financial industry and how everyone participates in the stock market. Online trading platforms have made it much more straightforward and less expensive to trade securities, vastly expanding the marketplace. Faster Internet speeds allow trades to get executed almost instantly, leading to innovations like High-Frequency Trading. Other innovations like Electronically Traded Funds (ETFs) have also become a popular way of investing in a diversified portfolio,

and reducing risk to the investor. Now that all trades are conducted electronically, it is much simpler to compile data and conduct analysis on the stock market, which can then be used by financial researchers and regulating agencies. All of the technologies combined are aimed towards creating a more stable and open market for everyone.

Even though technology has significantly improved financial services overall, there have also been adverse effects. With essentially no barriers to entry, anyone can become a trader, which is a risky practice. While there is much information on the Internet, it is impossible to be right all the time. When it comes to risky trading, it is better to know more than less, and with the Internet, more and more people have turned to the stock market to make money. As I have discussed, allowing inexperienced people to invest is a great thing, but there must be warnings in place to prevent a situation like Alex Kearns' from happening again. The technologies that enable modern stock trading on apps like Robinhood affect real people every day. Without the necessary education and safeguards in place, investors are at risk of making bad trading decisions, leading to other consequences. Technology has also exposed investors to a constantly changing news cycle, which affects the market in real-time. Anyone can access news from all over the world now and trade based on that news. That has caused the stock market to become more volatile and prone to more significant market swings. One can only expect the financial system to become even more digitized and reliant on technology in the future.

On top of that, millions of people are entering the market every month with new money and fresh ideas. They want to learn more and be a great investor, and the Internet has facilitated anyone to have that ability. More and more people will continue to enter the market, and likely social media and the news will have a more significant impact on the market going forward, as more people become connected to the Internet and the world of trading.

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