Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Master's Thesis

Analysis of Cannabis Biotech Stock

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

BcA. Christine Nabwire Ouma, BA (Hons)

Economics and Management

Thesis title

Biotech Stocks Analysis

Objectives of thesis

The cannabis and cannabinoid industry and markets are booming, and this is despite the COVID-19 pandemic. Thus this diploma thesis aims to carry out a comparative performance analysis of cannabis biotech stocks of the major players at NYSE and NASDAQ by determining the volatility of each individual firm's stock for the period of 2018 to 2022. It will comparatively analyze the performance of cannabis biotech stocks of ten major listed cannabis biotech firms at NYSE and NASDAQ stock exchange. The firms are selected as per their market capitalization and the year of IPO. The selected firms for this study are: TerrAscend, Cara Therapeutics, Aurora Cannabis, OrganiGram, Ayr Wellness, 22nd Century, Village Farm Interna, cbdMD, Corbus International, and Neptune Wellness Solutions. The study's goal is to provide valuable information to the investors and academic scholars on the viability of investing in cannabis biotech stock. The viability shall be determined using stock fundamental and technical price analysis.

Methodology

The study will use standard deviation method to determine the volatility of the selected biotech stocks from 2018 to 2022. Standard deviation method is preferred since it is the statistical measure of market volatility that measures how widely prices are dispersed from the average price. It also helps measure market and security volatility, and predict performance trends (Hargrave, 2021).

Data analysis and presentation will be carried out using a suitable statistical tool. To determine the volatility, standard deviation will be carried out on the historical monthly closing prices for the period of 2018 to 2022 of individual firms. The result will provide the yearly volatility of the stock prices of the listed firms. The standard deviation increases when there is a large up-or down-swing in price, which indicates high volatility. Conversely, a low standard deviation indicates minimal volatility when the gap between trading ranges is tight (Beers, 2022). The data to be used for analysis will be obtained from Yahoo Finance and NASDAQ. The results of the analysis will provide information on whether investing in cannabis biotech stocks is poses a high or low risk to the investors.

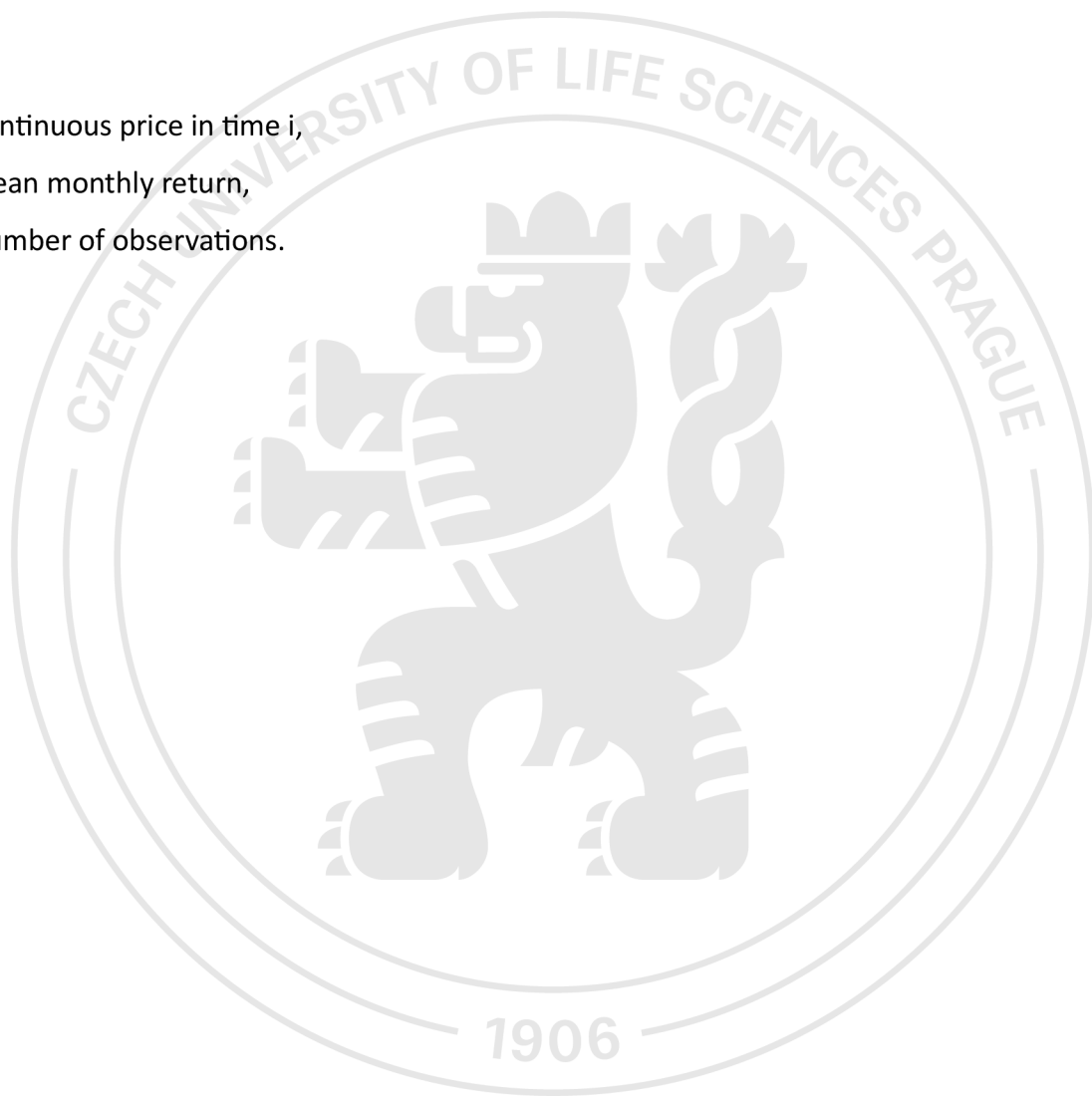The general formula of standard deviation is given as follows:

$$\hat{}\,\text{Standard Deviation} = \sqrt{} 1n - 1 \sum ni = 1(Xi - x)2$$

Where;

X is the continuous price in time i,

x̄ is the mean monthly return,

n is the number of observations.

Declaration

I declare that I have worked on my master's thesis titled " Analysis of Cannabis Biotech Stock " by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 31.03.2023 _____

The proposed extent of the thesis

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Keywords

cannabis, cannabinoid, biotechnology, marijuana, covid-19, NYSE, NASDAQ, biotech, SPSS, volatility, stocks

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Recommended information sources

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Analysis of Cannabis Biotech Stock

Abstract

The objective of this master's thesis is to analyse the stock performance of hemp biotechnology major companies listed on the NYSE and NASDAQ.

To this end, the study sought to answer research questions such as the volatility trend of hemp biotechnology stocks, the importance of stock volatility trend to investors, and the impact of financial ratios on stock volatility. The study used both ex post facto and descriptive research design and identified ten cannabis biotechnology companies based on the number of years they have been publicly traded in the stock markets and their market capitalization. The findings of the study, is presented in tables, figures and graphs, including monthly volatility and annualized volatility from January 2018 to August 2022.

Subsequently, the author concludes that cannabis biotechnology stocks are highly volatile due to uncertainty about the regulatory environment, lack of proven business models, and profitability among publicly traded companies. The author recommends that investors conduct thorough research before investing in these stocks and suggests further empirical studies be conducted in all stock markets around the world. In addition, future studies may focus on other financial ratios and their impact on the volatility of cannabis biotechnology stocks and use the exponentially weighted moving average (EWMA) model and histograms to determine stock volatility. In conclusion, investors may exercise caution as uncertainty makes it difficult to predict which stocks may outperform or underperform.

Keywords: cannabis industry, stock exchange, stock volatility, standard deviation, investment, cannabis biotech stock, New York Stock Exchange, NASDAQ, market capitalization.

Analýza biotechnologických zásob konopí

Abstrakt

Cílem této diplomové práce je analyzovat akciový výkon konopných biotechnologií velkých společností kótovaných na NYSE a NASDAQ.

Za tímto účelem se studie snažila odpovědět na výzkumné otázky, jako je trend volatility konopných biotechnologických zásob, význam trendu volatility akcií pro investory a dopad finančních ukazatelů na volatilitu akcií. Studie využila ex post facto i popisný design výzkumu a identifikovala deset konopných biotechnologických společností na základě počtu let, kdy byly veřejně obchodovány na akciových trzích, a jejich tržní kapitalizace. Výsledky studie jsou uvedeny v tabulkách, obrázcích a grafech, včetně měsíční volatility a anualizované volatility od ledna 2018 do srpna 2022.

Následně autor dochází k závěru, že akcie cannabis biotechnology jsou vysoce volatilní kvůli nejistotě ohledně regulačního prostředí, nedostatku osvědčených obchodních modelů a ziskovosti mezi veřejně obchodovanými společnostmi. Autor doporučuje, aby investoři před investováním do těchto akcií provedli důkladný výzkum, a navrhuje, aby byly provedeny další empirické studie na všech akciových trzích po celém světě. Budoucí studie se navíc mohou zaměřit na další finanční ukazatele a jejich dopad na volatilitu zásob konopí biotechnologie a použít exponenciálně vážený klouzavý průměr (EWMA) model a histogramy k určení volatility akcií. Závěrem lze říci, že investoři mohou být opatrní, protože nejistota ztěžuje předpovídání, které akcie mohou překonat nebo podhodnotit.

Klíčová slova: konopný průmysl, burza, volatilita akcií, směrodatná odchylka, investice, akcie konopí biotech, New York Stock Exchange, NASDAQ, tržní kapitalizace.

Table of contents

1 Introduction

The cannabis and cannabinoid industries and markets are booming. BDSA indicates that global cannabis sales reached $21.3 billion in 2020, a jump of nearly 50% compared to 2019. According to the Edison Group Report, the market value of cannabis products will reach $92 billion by 2040 (Edison Group, 2021). In the US, this industry had created over 321,000 full-time jobs by 2021 (Barcott, Whitney, and Bailey, 2021). The addressable market is large and growing fast, driven by increased consumer acceptance and changes in legislation. Advances in biotechnology, specifically biosynthesis, are creating the potential to produce high quality, sustainable, rare cannabinoids consistently, quickly, and at a lower cost than conventionally grown cannabis and hemp to meet this growing demand (Sarugaser and Freeman, 2020).

According to Grand View Research's Cannabis Market Analysis and Forecast report, the covid-19 pandemic severely impacted cannabis and derivative logistics networks, affecting even government-authorized dispensaries. The import and export of nearly all commodities, essential or not, got affected too. However, with the government's policies changing and the demand for medical marijuana also rising, the demand is likely to be high in the next few years (Grand View Research, 2022).

Many countries that have legalized the use of medical marijuana are also paving the way for its cultivation to reduce imports and generate revenue through taxes. As of 2021, a total of 35 countries had legalized marijuana for medical use, 16 of which allowed adults to legally use the substance for recreation (Deutsche Welle, 2021). Thus, the increase in stockpiling and positive consumer demand, combined with an increase in countries recognizing the commodity as essential for recreation and medicine, is expected to drive market growth in the coming years (FBS, 2021).

Furthermore, the investment rate in these stocks is increasing and expected to continue over the years. Reports by Yahoo Finance indicate that the cannabis stock market is booming now as compared to the pre-Covid-19 period (Lango, 2022). This is due to countries paving the way for more liberal policies regarding marijuana cultivation and use in the medical field, attracting more firms to the industry.

However, the dilemma remains in understanding the risk of investing in the industry, as most of the cannabis firms listed on the stock exchange have different price variations and

uncertain volatility (Silver, 2021). Empirical evidence on the volatility of the cannabis stock is scarce in both public and academic portals, therefore creating a knowledge gap that this study aims to fill.

In conclusion, it is important for investors to understand the financial reason for investing in cannabis stocks. The aim of this master's thesis is to carry out a comparative performance analysis of the cannabis biotech stock of some of the major players at NYSE and NASDAQ by determining the volatility of each individual firm's stock for the period between 2018 and 2022.

2 Objectives and Methodology

2.1 Objectives

The aim of this master's thesis is to comparatively analyze the performance of cannabis biotech stocks of the selected listed cannabis biotech firms. This is by analyzing the stock volatility trends and how financial ratios affect the stock volatility. The selection of firms for the study was made as per their market capitalization and the year of their IPO[1]. The selected firms for this thesis are: TerrAscend Corporation, Cara Therapeutics, Aurora Cannabis Incorporated, Canopy Growth, Compass Diversified, 22nd Century Group, Applied DNA Sciences, Innovative Industrial Properties, Corbus Pharmaceuticals Holdings, Inc., and Neptune Wellness Solutions.

2.2 Methodology

The master's thesis is divided into theoretical and practical parts. Overall, the information for the literature review is based on ex post facto (after-the-fact) research design and descriptive research design (Kowalczyk, 2022). The theoretical part of the thesis contains details about the cannabis plant, varieties, cannabis biotech market, stocks, stock market exchange, volatility, and basic introduction to each of the ten companies from their annual reports, websites, and relevant literature.

The practical part is based on stock data obtained from reputable online sources: Yahoo Finance and NASDAQ[2]. While financial ratios data is obtained from Macrotrends[3], Wall Street Journal, Market Screener, and Yahoo Finance among others. The analysis used in the thesis include Standard Deviation, Correlation, Residuals and Regression analysis.

Standard Deviation method determines the volatility of the selected biotech stocks from 2018 to 2022. It is preferred since it is the statistical measure of market volatility, measuring how widely prices are dispersed from the average price. It also helps measure market and

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[1] Market capitalization is the value of a company that is traded on the stock market, calculated by multiplying the total number of shares by the present share price while Initial Public Offering (IPO) refers to the process of offering shares of a private corporation to the public in a new stock issuance for the first time

[2] NASDAQ is an electronic stock exchange where investors can buy and sell on an automatic computer network. It provides stock data for all trading companies for free.

[3] Macrotrends is a premier research platform for long term investors which provides stock and financial data of companies around the globe. Access via www.macrotrend.com

security volatility, and predict performance trends (Hargrave, 2021). To determine stock volatility, historical monthly closing prices for the selected firms from January 2018 through August 2022 were used. The results provide monthly and annual volatility of the stock prices of these ten listed firms. The standard deviation increases when there is a large up-or down-swing in price, which indicates high volatility. Conversely, a low standard deviation indicates minimal volatility when the gap between trading ranges is tight (Beers, 2022). Both monthly and annual volatility are presented in charts generated using SPSS[4]

To establish the relationship between stock volatility and financial ratios, correlation and regression analysis are employed. Linear correlation analysis is a technique for representing the proximity of one variable to another. The linear correlation coefficient (r or R) is one such measure that provides information about how closely two variables are related (Senthilnathan, 2019). A correlation of -1, 0 represents a perfect negative correlation, while a correlation of 1, 0 represents a perfect positive correlation. A positive relationship exists if the correlation coefficient is greater than zero. A value less than zero, means the relationship is negative.

Regression analysis represents a set of statistical methods for estimating relationships between one or more independent variables and a dependent variable. It is used to assess the strength of the relationship between variables and to forecast their future relationship (Corporate Finance Institute, 2022). The multiple R^2 values indicate how much of the variation in the dependent variable is explained by the independent variable. An R^2 of 1 indicates that the regression predictions fit the data perfectly. Regression coefficients are useful as they help to determine how much a dependent variable will change with a unit change in the independent variable (Bandyopadhyay and Forster, 2011). If the coefficient is positive, it implies that there is a direct relationship between the variables, while if the coefficient is negative, it means that if the independent variable increases, the dependent variable decreases, and vice versa. The correlation and regression analysis results were represented in tables for comprehensive interpretation and conclusion.

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[4] SPSS is a statistical software designed by IBM to provide data analysis for descriptive and bivariate statistics, numeral outcome predictions and predictions for identifying groups.

3 Literature Review

3.1 What is cannabis?

Marijuana strains are generally categorized as *sativa, indica*, or a hybrid of both. The different types of weed vary based on both the type of plant they come from and the effects they have on a person or the type of high they give (Pruett, 2022).

Sativa strains tend to produce an energetic, euphoric buzz, while *indica* strains can be calming and relaxing (Hartney, 2011). Each cannabis strain has different concentrations of cannabinoids such as tetrahydrocannabinol (THC) that can cause a high, cannabidiol (CBD) that does not cause a high, and other compounds. Figure 1 is a picture of cannabis leaves.

Figure 1: Cannabis leaves

Source: Pixabay.com

Cannabis sativa

Cannabis sativa originates from warmer climates, such as Mexico and South Africa, and tends to grow very tall with long, thin leaves. *Sativa* has lower THC levels compared to indica, but higher levels of CBD. *Sativa* strains have energizing effects; thus, people prefer to consume weed from these strains in the morning or afternoon (Pruett, 2022). Three popular sativa strains are Acapulco Gold, Panama Red, and Durban Poison (Holland, 2019).

Cannabis indica

The *Cannabis indica* plant originates from the Middle East, in places such as Afghanistan, Pakistan, and Tibet. It generally has a higher CBD content than *cannabis sativa*, with the CBD to THC ratio being almost 1:1 (Wilson, 2020). Table 1 shows cannabis strain names and their plant species.

Table 1 Cannabis Strains

Strain name	Plant species
Kush	Pure *Cannabis indica* or *Cannabis indica* hybrid
Afghan Kush, Hindu Kush, Green Kush, Purple Kush	Pure *Cannabis indica*
Blueberry Kush, Golden Jamaican Kush	*Cannabis indica* hybrid
Diesel Haze	Pure *Cannabis sativa* or *Cannabis sativa* hybrid

Source: Chen (2020)

As more countries legalize marijuana use for both medical and recreational purposes, there is growing interest in the different effects that different types of drugs can have.

3.2 Cannabis Biotech Market

Human beings have long used cannabis *sativa L.* (hemp) for food, fibre, medicine, and its psychoactive properties (Salami et al., 2020). The species can be divided into groups based on their taxonomic relationships or chemotypes but is frequently subdivided and controlled according to the quantity of psychoactive cannabinoids produced.

During the last decade, the industrial properties of cannabis for applications in textiles, paper, building materials, cosmetics, foods, and pharmacological properties have been broadly studied and supported. Isolated cannabinoids are now legal for the development of medicinal and edible products (Torkamaneh and Jones, 2021).

The cannabis market is growing rapidly as more nations across the globe continue to legalize it for agricultural, medicinal, and industrial use. Research & Markets' report indicates that the global cannabis market may reach $176 billion at a CAGR of 23.9% by 2030.

Armstrong (2021) observed that the share of legal recreational products in Canada's overall cannabis consumption began at 7.8% in October 2018 and grew to 23.7% by September 2019, with an average of 14.5% over the first 12 months of its legalization.

In the U.S., the cannabis market was valued at USD 10.8 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 14.9% from 2022 to 2030 (Grand View Research, 2022). In the UK, the research indicates that the medical cannabis market could be worth over £453 million by 2026, which is almost a quarter of the total European market share.

This recent boom and rapid growth of cannabis market is mainly because of public support and governments' legalization. Some of the changes that have been made by developed nations in the world include:

- Canada legalized recreational marijuana use in 2018.
- US states are legalizing marijuana at a rapid pace; over fifty percent of Americans live in a state where some form of cannabis is legal. This has led to an increase in demand for products like CBD oil, which is non-psychoactive and can be used to treat various conditions without getting high.
- A bill to legalize medical marijuana in New York was passed in December 2021 by the state's legislature.[5]
- In March 2021, the Thai government announced that it would legalize and regulate the cultivation, sale, and use of cannabis for medical purposes.
- In January 2022, Germany became the first country in Europe to legalize cannabis for recreational use.

Compared to other industries, cannabis has had a slow start. For decades, innovation has been relatively idle given factors like prohibition. However, with public support and legalization, cannabis has become a multibillion-dollar industry. In addition, the industry is supported by a robust supply chain of growers, retailers, support systems, and biotechnology companies, through which the industry continues to grow (Ali, 2022). The cannabis industry's momentum has stirred up investor interest across the board as seen through the

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[5] NY State Senate Bill S854A

average size of cannabis equity capital raises, which grew 165% from $7.5 million in 2020 to $19.1 million in 2021.

3.2.1 Cannabis Biotech Stock

Over the past few years, investing in the cannabis industry has gained significant momentum as cannabis is becoming legal in a growing number of nations. The medicinal and recreational cannabis industries dominate this relatively new market.

Bahji and Stephenson (2019) state that cannabis has been legalized for recreational (and frequently medicinal) use in many states in the United States, including Colorado and California. Additionally, many nations: Uruguay, Spain, the Netherlands, Canada, the Czech Republic, eSwatini, Zambia, Uganda, and Rwanda, passed or are in the process of passing laws allowing the use of cannabis for recreational and/or medicinal purposes (Rapaport, 2020).

Investors face risks when investing in cannabis stocks (Parker et al., 2019). Future investments in these stocks may be undermined by market and pricing risks, legal risks, such as restrictions on banking and insurance, supply chain risks, and funding risks (Papadamou et al., 2022). Trading volume has increased especially since the middle of 2018 for these stocks, despite the risks (Kazemi, 2019).

According to Proctor (2022), the cannabis stock market can be divided into four different segments in the industry. These include manufacturers, who provide auxiliary support to the industry and are engaged in cannabis extraction, product preparation, packaging, and labelling; retailers, who include dispensaries in states where residents can buy marijuana and cannabis-related products; growers, who are businesses that own marijuana farms and actively cultivate the plant; and drug-makers, who are pharmaceutical firms that use biotechnology to create drugs derived from the plant. However, most cannabis businesses engage in several of those segments and not just one.

Although recreational marijuana market keeps attracting investors as more states pass legislation, the medical marijuana market currently offers strong short-term income potential. Individual stocks and marijuana ETFs are the two primary forms of marijuana investments. ETFs enable a person to diversify their investment across businesses in the entire marijuana industry (Proctor, 2022). Individual stocks will be the main subject of this study.

15

3.3 Financial Ratios

Financial ratios are calculated using numerical values from financial statements to provide meaningful information about a company (Corporate Finance Institute, 2022). Income statements, balance sheets, and cash flow statements are examples of financial statements.

Six fundamental ratios are frequently employed when choosing stocks for investment portfolios. The working capital ratio, the quick ratio, the price-earnings ratio, the debt-to-equity ratio, and the return on equity (ROE) are among them (Wilkins, 2020). The working capital ratio, EPS, P/E ratio, and ROE ratios were examined in this study because it is believed that they are the best indicator of a stock's performance.

The asset-to-liability ratio, or how many times a company can pay off its current liabilities with current assets, is represented by the working capital ratio (American Express, 2022). To determine earnings per share (EPS), a company's revenue is divided by the total number of outstanding shares of common stock. The resulting figure is used to assess the profitability of the business (Fernando, 2022). A company's current share price contrasted with its earnings per share determines its price-to-earnings (P/E) ratio, which reflects the measure of its valuation. A high P/E ratio means that investors can be more optimistic about future earnings growth than when it is low (Fernando, 2022b). Return on equity (ROE) examines how an organization spends the money that its investors have invested in it (Fuhrmann, 2019).

3.4 Stock Exchange Markets

According to Harper (2020), the stock exchange is a centralized market which connects businesses and governments so that investors can buy and sell stocks. There are various financial products present, such as bonds, commodities, and stocks. Companies can raise capital on stock exchanges, and investors can use this information to make educated investment decisions. Exchanges can be a physical location or an electronic trading platform (Corporate Finance Institute, 2019).

Historically, stock exchanges were primarily physical spaces where men shouted buy and sell orders from the floor. In today's exchanges, computers match buyers and sellers and are largely virtual (Saad, 2022).There are numerous stock exchange markets around the

world; however, the New York Stock Exchange (NYSE) and NASDAQ will be the only ones examined in this study.

3.4.1 New York Stock Exchange (NYSE)

The Financial District of Lower Manhattan in New York City is home to the American stock exchange known as the New York Stock Exchange. It can be traced back to the Buttonwood Pact signed by 24 stockbrokers on May 17, 1792, as a response to the first financial panic. It established fixed commissions and rules for stock trading. Additionally, investors and entrepreneurs can use it as the world's largest stock exchange to raise capital and even change the world.

3.4.2 NASDAQ

In 1971, the Financial Industry Regulatory Authority (FINRA), then known as the National Association of Securities Dealers (NASD), established NASDAQ as a wholly owned subsidiary. In the year 2000, the NASD began a process of reorganization and sold members' shares in the electronic exchange which is the first electronic one ever. In the United States and Europe, it runs 29 markets, a clearinghouse, and five central securities depositories.

3.5 Stock Volatility

According to Mullins (2000), volatility is the degree to which the price of a security, commodity, or market varies in a short period of time. Peiris and Peiris (2011) claim that volatility has an effect on market risk and is associated with unpredictability and uncertainty. Volatility is typically regarded as a sign of market disruption, in which the capital market is not operating as expected and securities are not being priced fairly. Changes in the unpredictability of financial exchange returns have the potential to have a significant impact on speculative financial backers as well as the economy.

Kazemi (2019) observed that cannabis stocks exhibit high volatility due to the fact that they reflect the inherent risk of these stocks gapping up or down. Investors should avoid being solely enticed by the appeal of selling them unless their strategy is based on a strong theme or rationale and must be carried out with proper risk management. However, their

inclusion enhances yield and diversification in an investor's portfolio due to their high volatility and returns (Papadamou, 2022).

Current literature on cannabis stock volatility is still lacking, forcing interested investors and academic scholars to rely on information from the firms themselves, which is both costly and time consuming. As a result, the goal of this study is to fill that void by examining the performance of ten NYSE and NASDAQ cannabis biotech stocks, particularly during the pre- and post-covid-19 periods.

3.6 Listed cannabis biotech firms on NYSE and NASDAQ

3.6.1 TerrAscend Corp.

Company outline: It is based in Canada and is also a leading cannabis company in North America with operations in Pennsylvania, New Jersey, Michigan, and California. It has cultivation and processing licenses in Maryland. TerrAscend runs a network of cultivation, processing, manufacturing, and retail Apothecarium dispensary locations. On NASDAQ, it trades with the ticker symbol TRSSF. It went public in May 2017.

Market cap and Net Income: The market capitalization of the company was $0.01 billion in 2018, $0.03 billion in 2019, $0.16 billion in 2020, $0.54 billion in 2021, and $0.54 billion in 2022, respectively (Market Screener, 2022, and Companies Market Cap, 2023). For the years 2019, 2020, 2021, and 2022, respectively, the net income was $-154M, $-124M, $3.11M, and $-329M. (Market Screener, 2022).

3.6.2 Cara Therapeutics

Company outline: Cara Therapeutics is a clinical-stage biopharmaceutical company that centers on developing therapeutic solutions to treat diseases associated with pain and inflammation. It studies and develops cannabinoid receptors for pain alleviation. The company got its IPO in 2014. The stock symbol on NASDAQ is CARA.

Market cap and Net Income: The company's market capitalization for the years 2018, 2019, 2020, 2021, and 2022 was $0.55B, $0.33B, $0.47B, $0.57B, and $0.55B, respectively (Companies Market Cap, 2023). The net income for the company for the years 2018, 2019, 2020, 2021, and 2022 was $-74M, $-106M, $8.41M, $-88.4M, and $-85.5M, respectively (Market Screener, 2023).

3.6.3 Aurora Cannabis Inc.

Company outline: Edmonton, Alberta, is home to Aurora Cannabis Inc., a licensed cannabis manufacturer in Canada. It trades as ACB on NASDAQ. In 2017, the company went public and operates in 25 countries across five continents (Macro Trends, 2023).

Market cap and Net Income: Aurora Cannabis' market capitalization for the years 2018, 2019, 2020, 2021, and 2022 was $5.61B, $2.11B, $1.92B, $0.24B, and $0.24B, respectively (Companies Market Cap, 2023a). The company's net income for the years 2018, 2019, 2020, 2021, and 2022 was $ 56.8M, $ -229.5M, $ -2.6B, $-521.9M, and $-1.3B, respectively.

3.6.4 Canopy Growth

Company Outline: Cannabis and hemp-based products for recreational and medical use are produced, distributed, and sold by Canopy Growth Corporation and its subsidiaries primarily in Germany, the United States, and Canada. Dried cannabis flower, extracts, vapes, concentrates, beverages, and gummies are among their offerings. In 2018, they went public and became the first cannabis producer on the NYSE: Their ticker sign is CGC.

Market cap and Net Income: According to Macro Trends (2023b), Canopy Growth's market capitalization for 2018, 2019, 2020, 2021, and 2022 was $11.05 billion, $6.67 billion, $6.39 billion, $1.01 billion, and $1.01 billion, respectively. While the organization's net income for the years 2018, 2019, 2020, 2021, and 2022 was USD - 55.68M, $-541.15M, $-1042.59M, $-1376.55M, and $-238.58M, respectively.

3.6.5 Compass Diversified

Company outline: This private equity company focuses on late-stage and middle market investments, acquisitions, buyouts, industry consolidation, and recapitalization. It makes investments in manufacturing, distribution, consumer goods, business services, safety and security, electronic components, food services, as well as niche industrial or branded consumer products. The company also makes a lot of investments in North American-based businesses. It trades in NYSE as CODI and got its IPO in 2006.

Market cap and Net Income: While for the years of 2018, 2019, 2020, 2021, and 2022 it was $0.74B, $1.48B, $1.26B, $2.01B, and $1.31B, respectively (Companies Market Cap,

2023c). The company's net income for those years was $- 5.70M, $302M, $22.8, $115M, and $36.4M, respectively.

3.6.6 22nd Century Group

Company outline: It is a top company in plant biotechnology, specializing in techniques that use modern plant breeding, gene editing, and genetic engineering to change the amounts of cannabinoids in hemp and cannabis plants as well as the level of nicotine in tobacco plants. The company got its Initial Public Offering in 2011: XXII is the NASDAQ symbol.

Market cap and Net Income: The market capitalization for the company for the years 2018, 2019, 2020, 2021, and 2022 was $0.31B, $0.15B, $0.30B, $0.50B, and $0.19B, respectively (Companies Market Cap, 2023). The company's net income for the years 2019, 2020, 2021, and 2022 was $-26.559, $19.7, $-32.6M and $-59.8M, respectively (Market Screener, 2023).

3.6.7 Applied DNA Sciences

Company outline: This company develops and sells DNA-based technology solutions for manufacturing and development of nucleic acid-based drugs; also, for store network security, hostile to duplicating, and against robbery innovation properties. They trade on NASDAQ as APDN and got their IPO in 2015 with additional upsizing IPOs in the years after.

Market cap and Net Income: The market capitalization for the company in the years 2018, 2019, 2020, 2021 and 2022 was $14.24M, $14.6M, $28.87M, $30.09M, and $21.42M, respectively (Companies Market Cap, 2023). The company's net income for the years 2018, 2019, 2020, 2021, and 2022 was $-11.7M, $-8.93M, $-13M, $-14.3M and $-8.38M, respectively (Market Screener, 2023).

3.6.8 Innovative Industrial Properties

Company outline: It is a self-managed firm based in Maryland that acquires, owns, and administers specialized premises that are leased to seasoned, state-licensed operators for their requirements for regulated medical-use cannabis facilities. It became publicly traded in 1997 and uses the ticker symbol IIPR on the NYSE.

Market cap and Net Income: The market capitalization for IIR for the years 2018, 2019, 2020, 2021, and 2022 was $0.44 B, $0.95 B, $4.06 B, $6.29 B, and $2.83 B, respectively (Companies Market Cap, 2023). The company's net income for the years 2018, 2019, 2020, 2021, and 2022 was $5.63M, $22.1M, $64.4M, $113M, and $153M, respectively (Market Screener, 2023).

3.6.9 Corbus Pharmaceuticals Holdings

Company outline: Corbus Pharmaceuticals Holdings, Inc. is a clinical-stage company that develops and commercializes novel medicines designed to target the endocannabinoid system. The company got its IPO in 2015. The symbol on NASDAQ is CRBP.

Market cap and Net Income: The market capitalization for the company for the years 2018, 2019, 2020, 2021, and 2022 was $0.33B, $0.35B, $0.10B, $77.1M, and $13.84M, respectively (Companies Market Cap, 2023). The company's net income for the years 2018, 2019, 2020, 2021, and 2022 was $- 55.7M, $-71.5M, $-111M, $-45.6, and $-42.3M, respectively (Market Screener, 2023).

3.6.10 Neptune Wellness Solutions, Inc

Company outline: It is a diversified wellness company that sells consumer packaged goods, nutraceuticals, hemp products, and legal cannabis to businesses and consumers alike. For the Canadian and global medical cannabis communities, it extracts, purifies, and creates cannabis oil. It got its IPO in 2005 and trades as NEPT on NASDAQ.

Market cap and Net Income: The market capitalization of the company for the years 2018, 2019, 2020, 2021, and 2022 was $0.20B, $0.25B, $0.20B, $65.61M, and $3.69M, respectively (Companies Market Cap, 2023). The company's net income for the years 2019, 2020, 2021, and 2022 was $-23.2M, $-60.9M, $-167M, and $-97M, respectively (Market Screener, 2023).

4 Practical Part

4.1 Stock Price Returns and Volatility

To comparatively analyze the stocks data in this part, returns are calculated from the adjusted closing price of each month for the period of January 2018 to August 2022. The results are presented in tables for individual cannabis biotech companies selected for this study. The returns are calculated using the natural logarithm (LN). The natural logarithm (LN) is the ratio of the current closing price to that of the previous month. For monthly returns, volatility is determined using the standard deviation method. To annualize volatility, the square root function is used. This involves multiplying monthly volatility by the total number of months in a year, which is 12 months.

TerrAscend Corp (TRSSF)

Table 2 TerrAscend monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.0558	-0.0868	-0.0663	0.1046	0.0765
March	0.6034	-0.0400	-0.1963	-0.2409	0.0124
April	-0.3137	0.0427	0.2017	0.0894	-0.1833
May	0.1377	-0.0618	0.0648	0.0395	-0.1407
June	0.0617	-0.0564	-0.0829	-0.0068	-0.4300
July	0.0089	-0.0969	0.5066	-0.2926	0.0351
August	0.2804	0.0033	0.5156	-0.1309	-0.1864
September	0.2391	-0.2213	-0.1093	0.0000	
October	0.3903	-0.0709	0.3403	-0.1818	
November	-0.2544	-0.2684	0.7064	0.0424	
December	-0.1812	-0.1544	0.0172	0.0185	
Av. monthly volatility	*0.2824*	*0.0918*	*0.3028*	*0.1372*	*0.1756*
Annualized Volatility	**0.9784**	**0.3181**	**1.0489**	**0.4751**	**0.6084**

Source: Own research based on stocks data

Table 2 shows that TerrAscend had the highest negative monthly stock price returns in 2019 for 9 months, while the highest positive return was observed in 2020, where investors saw 7 months of positive returns in that year.

Figure 2 TerrAscend Corp stock volatility
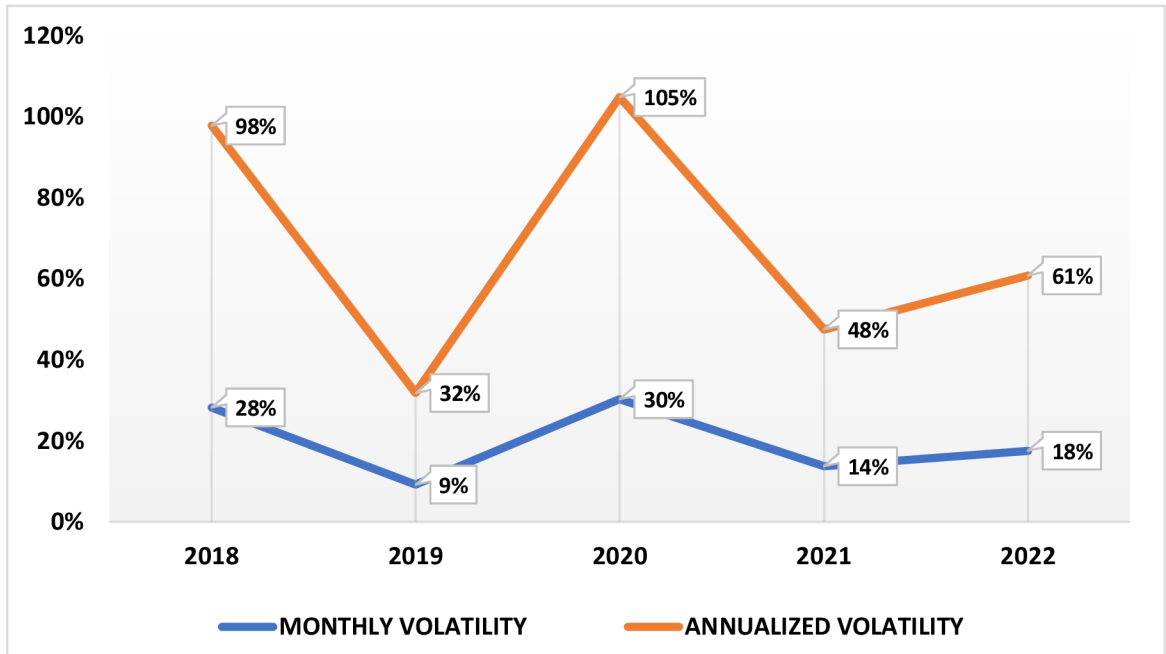
Source: Own research based on stocks data

The highest monthly volatility was in 2020 with an average of 30% while it experienced the lowest monthly rate in 2019 of 9%. The company had the highest annual volatility rate in 2020 with a rate of 105% and the lowest rate of 32% in 2019 (Figure 2).

Cara Therapeutics (CARA)

Table 3 Cara Therapeutics monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.0470	0.1180	-0.0665	-0.0187	-0.1045
March	-0.1144	0.1507		0.1831	0.1716
April	0.0000	-0.0275	0.1219	-0.4035	-0.2823
May	0.2633	0.0776	0.0709	0.0494	-0.0459
June	0.2244	0.0457	0.0775	0.0500	0.0974
July	-0.0637	0.1135	-0.0386	-0.1612	-0.0427
August	0.1249	-0.0209	-0.0572	0.3183	0.1808
September	0.1874	-0.2201	-0.1790	-0.0209	
October	-0.2175	0.1357	0.0420	0.0893	
November	-0.0299	0.2514	0.1063	-0.2169	
December	-0.2849	-0.3799	0.0314	-0.0759	
Av. monthly volatility	0.1786	0.1811	0.0979	0.1965	0.1664
Annualized Volatility	0.6187	0.6272	0.3391	0.6808	0.5763

Source: Own research based on stocks data

According to Table 3, CARA observed the least monthly returns in 2020, while it observed the highest monthly returns in 2021 of 0.1965.

Figure 3 CARA stock volatility
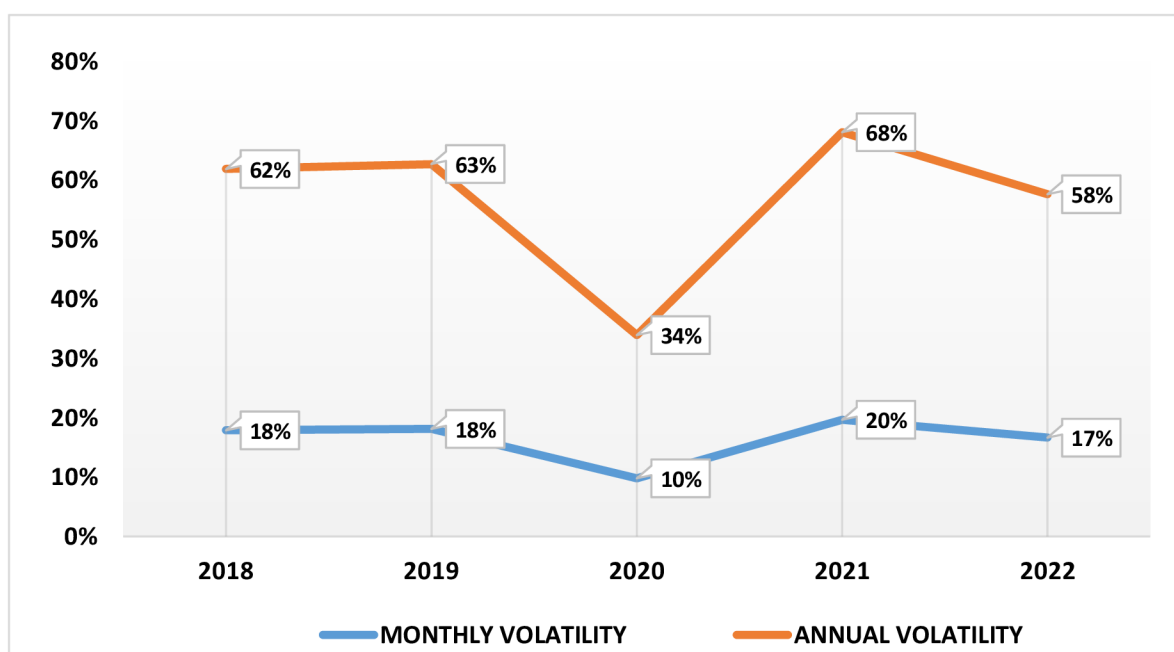
Source: Own research based on stocks data

The highest monthly stock volatility for CARA was observed in 2021 of 20%. While the highest rate of annualized volatility was in 2021 with a value of 68% while the least observed rate was in 2020 with a rate of 34% (Figure 3).

Aurora Cannabis (ACB)

Table 4 Aurora Cannabis monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.1516	0.0663	-0.2910	-0.0565	-0.0865
March	-0.1025	0.1984	-0.3239	-0.1150	0.0526
April	-0.1336	0.0022	-0.1832	-0.0397	-0.2425
May	-0.0078	-0.1641	0.5856	0.0805	-0.4521
June	0.1312	0.0303	-0.1179	-0.0642	-0.2048
July	-0.2291	-0.2008	-0.1795	-0.2235	0.0682
August	0.2257	-0.1200	-0.0383	0.0570	0.1348
September	0.4371	-0.2018	-0.5255	-0.0674	
October	-0.2917	-0.1822	-0.1290	-0.0419	
November	-0.1588	-0.3036	1.8840	-0.0317	
December	-0.1329	-0.1360	-0.2885	-0.1573	
Av. monthly volatility	0.2181	0.1476	0.6727	0.0862	0.2090
Annualized Volatility	0.7554	0.5114	2.3302	0.2985	0.7239

Source: Own research based on stocks data

In 2021, Aurora Cannabis had the highest monthly stock return ratio in 2018, while the least was observed in 2019 as shown in Table 4 above.

Figure 4 Aurora Cannabis Stock Volatility
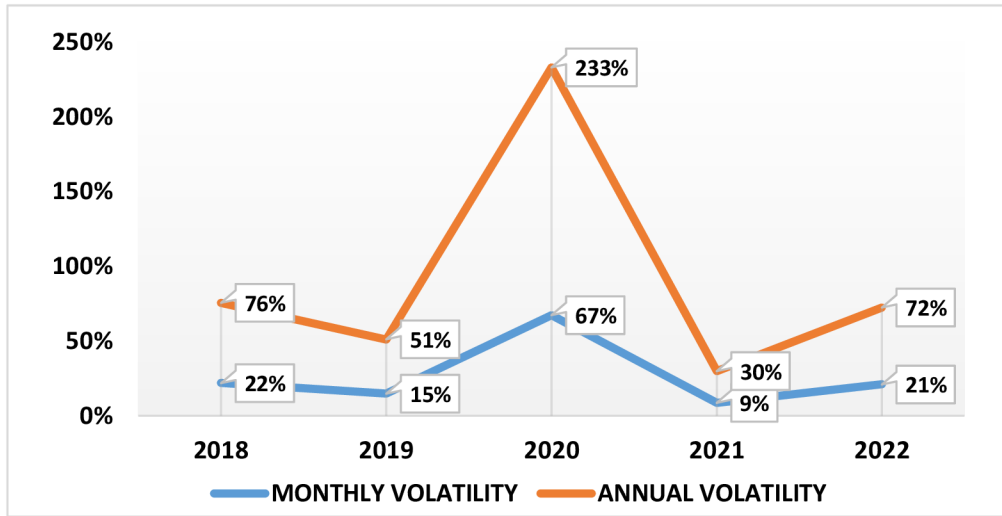
Source: Own research based on stocks data

In 2021, Aurora had the lowest monthly stock volatility rate of 9%, while in 2020, the monthly volatility rate was high with a value of 67%. The company had the highest annualized stock volatility in 2020 at a rate of 233%, while the lowest annualized volatility was observed in 2021 with a rate of 30%, as shown in Figure 4 above.

Canopy Growth (CGC)

Table 5 Canopy Growth monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.1541	-0.0321	-0.1672	-0.1827	-0.1144
March	0.2253	-0.0852	-0.2322	-0.0220	0.0646
April	-0.1027	0.1649	0.1096	-0.1586	-0.2467
May	0.2103	-0.2031	0.0856	-0.0319	-0.1296
June	0.0324	0.0012	-0.0697	-0.0732	-0.4266
July	-0.1011	-0.1903	0.1312	-0.2179	-0.0772
August	0.7364	-0.2776	-0.0963	-0.0888	0.3992
September	0.0639	-0.0276	-0.1332	-0.1956	
October	-0.2416	-0.1295	0.3115	-0.0887	
November	-0.0905	-0.0686	0.5335	-0.1520	
December	-0.1991	0.1345	-0.1444	-0.1849	
Av. monthly volatility	0.2793	0.1357	0.2330	0.0685	0.2588
Annualized Volatility	0.9675	0.4699	0.8072	0.2373	0.8967

Source: Own research based on stocks data

CGC had the least monthly returns in 2021 of 0.0685, where all the months returned a negative value, followed by 2019 as shown in Table 5 above.

Figure 5 Canopy Growth Stock Volatility
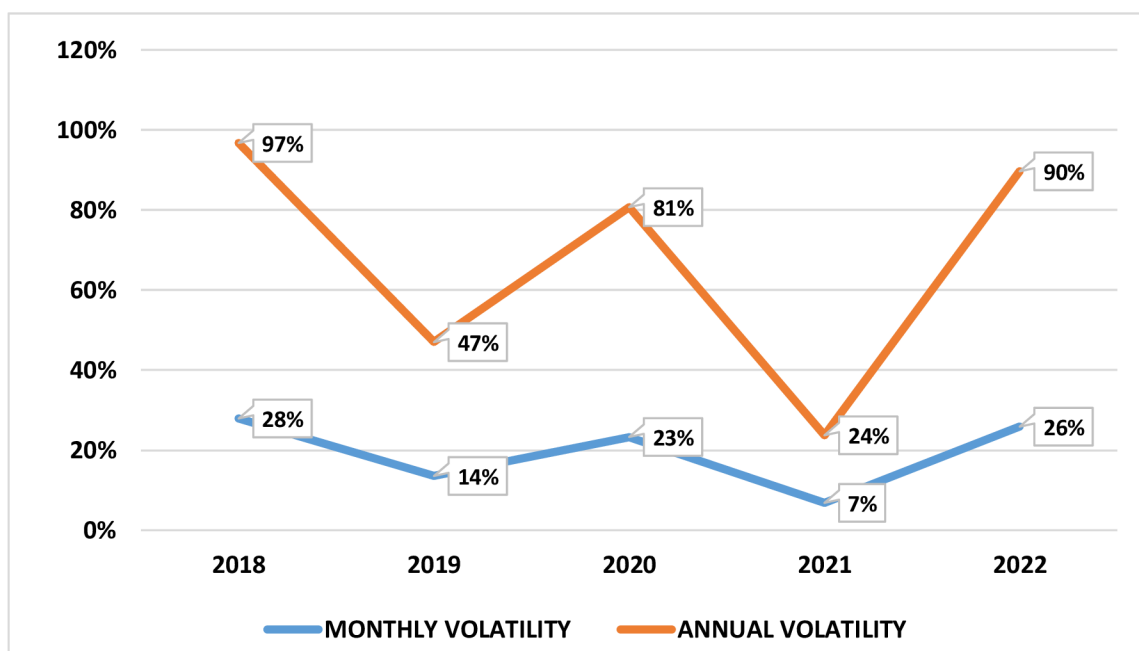
Source: Own research based on stocks data

The highest monthly volatility for CGC was in 2018 with a rate of 28%, while the lowest was in 2021 with a rate of 7%. The highest annual volatility rate was observed in 2018 with a rate of 97%, while the least annual rate was 24% in 2021 (Figure 5).

Compass Diversified (CODI)

Table 6 CODI monthly stock returns

	2018	2019	2020	2021	2022
January					
February	0.0093	0.0659	-0.2016	0.1676	-0.0472
March	-0.0180	-0.0032	-0.2690	-0.0211	0.0004
April	-0.0549	0.0542	0.4993	0.0989	-0.0804
May	0.0848	-0.0392	-0.1362	0.0348	0.0484
June	0.0517	0.2289	0.0159	-0.0173	-0.0556
July	0.0058	0.0047	-0.0748	-0.0208	0.1265
August	0.0440	-0.0059	0.1208	0.1563	-0.1258
September	0.0197	0.0518	0.0891	0.0197	
October	-0.1289	0.0477	-0.0929	0.0596	
November	-0.0127	0.1687	0.1530	-0.0235	
December	-0.1857	0.0489	-0.0061	0.0614	
Av. monthly volatility	0.0799	0.0787	0.2099	0.0699	0.0850
Annualized Volatility	0.2767	0.2725	0.7270	0.2420	0.2946

Source: Own research based on stocks data

CODI observed the highest number of months with a negative return in 2020 while the least number was in 2019 as shown in Table 6 above.

Figure 6 CODI Stock Volatility
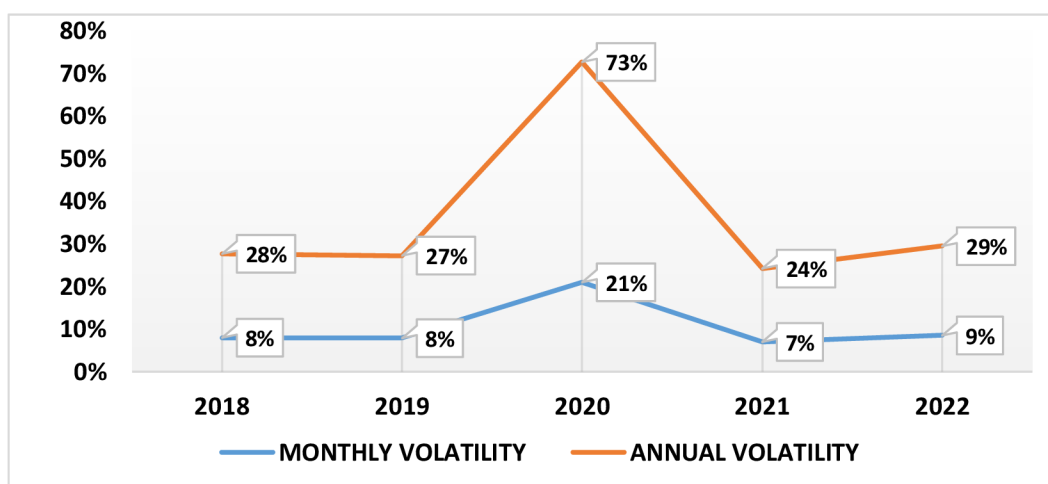
Source: Own research based on stocks data

In 2020, CODI had the highest monthly volatility with a rate of 21%, while the least was observed in 2021, with a rate of 7%. The highest annual volatility was observed in 2020 at a rate of 73%, while the least annual volatility was in 2021 with a rate of 24% as shown in Figure 6 above.

22nd Century Group Inc (XXII)

Table 7 XXII monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.2639	0.0759	-0.2017	0.3400	0.0783
March	-0.0637	-0.2905	0.0135	-0.0179	-0.0085
April	-0.1191	0.2807	0.2533	0.4225	-0.1767
May	0.0242	-0.1279	-0.1191	-0.0385	-0.0471
June	0.1604	0.0942	-0.0773	0.0289	0.1703
July	0.0163	-0.2392	0.0366	-0.3067	-0.2113
August	0.0840	0.2327	-0.2551	0.1121	-0.2024
September	0.0369	0.1531	0.0864	-0.1709	
October	-0.1388	-0.1637	0.1342	-0.0743	
November	0.2562	-0.4550	1.1871	-0.0839	
December	-0.1809	0.0680	0.3836	0.2311	
Av. monthly volatility	*0.1540*	*0.2356*	*0.3981*	*0.2193*	*0.1482*
Annualized Volatility	*0.5336*	*0.8160*	*1.3789*	*0.7595*	*0.5132*

Source: Own research based on stocks data

The highest number of negative returns was in 2021 while the least was in 2020 as shown in Table 7 above.

Figure 7 XXII stock volatility
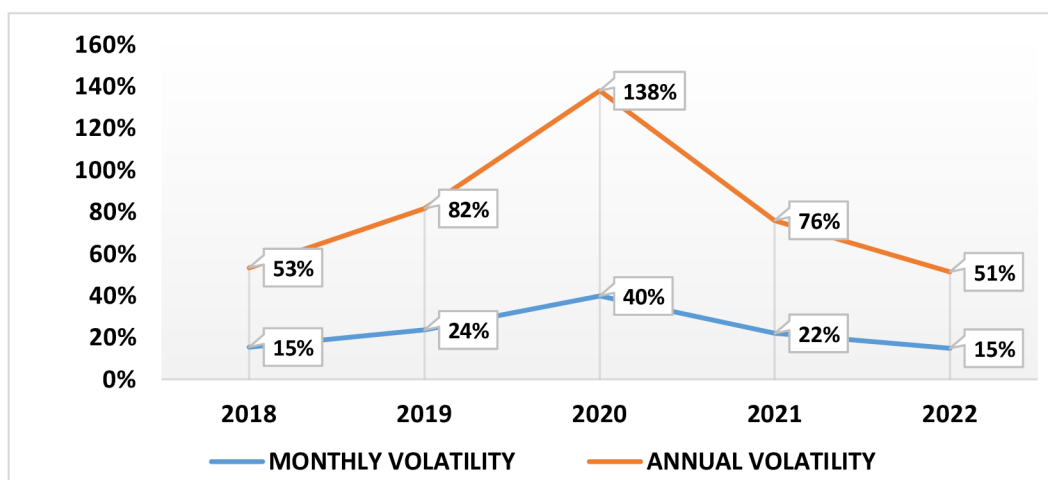
Source: Own research based on stocks data

Figure 7 indicates that XXII had the highest monthly stock volatility in 2020 at a rate of 40%, while least was in 2018 and 2022 at a rate of 15%. The highest annual volatility was observed in 2020 at a rate of 138%, while the least was in 2020 at a rate of 51%.

Applied DNA (APDN)

Table 8 Applied DNA monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.0461	0.5227	0.0528	-0.1966	-0.2242
March	-0.0069	0.0597	0.0075	-0.1966	-0.1641
April	0.0486	-0.1690	0.7114	-0.0445	-0.2523
May	-0.0132	0.0000	0.4128	-0.1572	-0.1938
June	-0.1544	-0.1525	-0.1698	0.1727	-0.4264
July	0.0952	-0.4000	0.2392	-0.2077	-0.0405
August	-0.1159	0.0333	-0.2670	0.0892	3.3944
September	0.2213	-0.2903	0.0546	-0.0802	
October	-0.2617	-0.2273	-0.0026	-0.0019	
November	0.0000	-0.3853	-0.0246	0.0743	
December	-0.6364	0.0024	-0.3218	-0.3045	
Av. monthly volatility	**0.2247**	**0.2612**	**0.3000**	**0.1495**	**1.3698**
Annualized Volatility	**0.7783**	**0.9047**	**1.0394**	**0.5179**	**4.7450**

Source: Own research based on stocks data

The year 2021 had the highest number of months with negative returns while 2020 had the least number of negative returns as shown in Table 8.

Figure 8 Applied DNA stock volatility
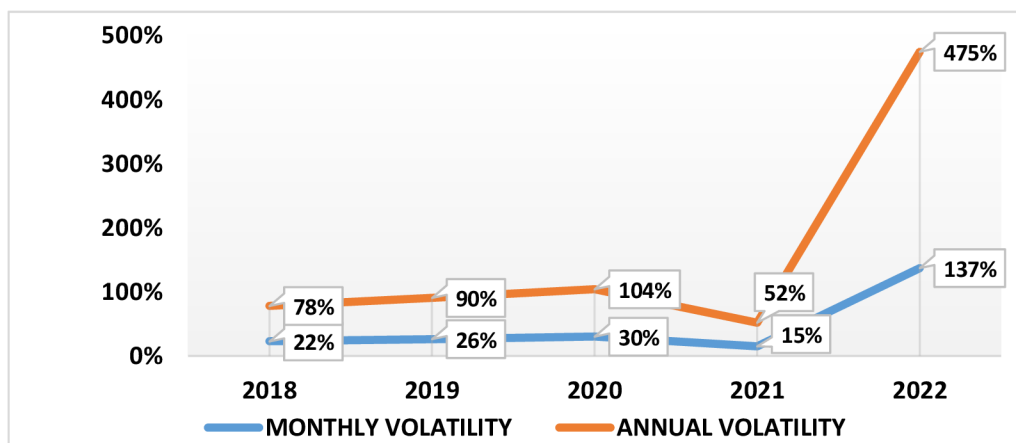
Source: Own research based on stocks data

APDN experienced the highest monthly volatility in the first 8 months of 2022 at a rate of 137%, while the least rate was observed in 2021 at a rate of 15%. The highest annual volatility was in 2022 at a rate of 475%, while the least volatility rate was in 2021 at a rate of 52% as indicated in Figure 8.

Innovative Industrial Properties (IIPR)

Table 9 IIPR'S monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.1264	0.2757	0.0273	0.0421	-0.0491
March	0.0717	0.0342	-0.1741	-0.0761	0.0899
April	0.2886	0.0477	0.0463	0.0243	-0.2901
May	0.1005	-0.0130	0.0415	-0.0158	-0.0798
June	-0.0253	0.4704	0.0771	0.0599	-0.1742
July	-0.1098	-0.1407	0.1984	0.1336	-0.1088
August	0.4021	-0.1562	0.1809	0.1438	-0.0486
September	0.0626	0.0360	0.0083	-0.0599	
October	-0.1439	-0.1704	-0.0516	0.1454	
November	0.2040	0.0186	0.3175	-0.0238	
December	-0.0802	-0.0199	0.1918	0.0237	
Av. monthly volatility	0.1800	0.1905	0.1362	0.0788	0.1178
Annualized Volatility	0.6234	0.6599	0.4719	0.2729	0.4080

Source: Own research based on stocks data

The highest number of months with negative returns was observed in 2022 while the least number of negative returns was observed in 2020 as shown in Table 9 above.

Figure 9 IIPR stock volatility
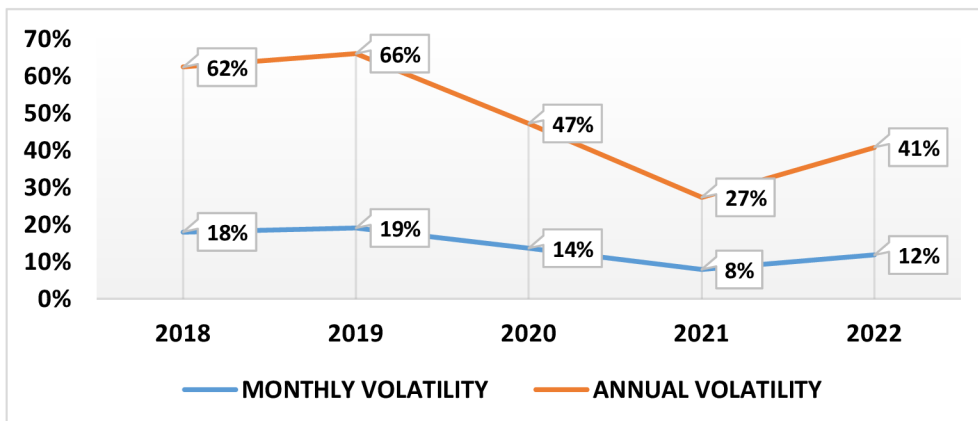
Source: Own research based on stocks data

Figure 9 indicates the IIPR had the highest monthly volatility in 2019 at a rate of 19%, while the lowest volatility was in 2021 at a rate of 8%. The highest annual volatility was observed in 2019 at a rate of 66%, while the lowest was observed in 2021 at a rate of 27%.

Corbus Pharmaceuticals (CRBP)

Table 10 CRBP'S monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.0133	-0.0820	-0.2674	0.1913	-0.2136
March	-0.1757	0.0014	0.1055	-0.0963	0.5376
April	-0.0246	0.0273	0.2366	-0.0863	-0.3628
May	0.0420	-0.0182	0.1512	0.2056	-0.1062
June	-0.1855	-0.0114	0.1247	-0.1567	-0.1683
July	0.0000	-0.1342	-0.2527	-0.2514	0.0040
August	0.1584	-0.1367	0.4809	-0.0584	-0.2016
September	0.2906	-0.0598	-0.8061	-0.2093	
October	-0.1179	0.0616	-0.4778	-0.0196	
November	0.0360	-0.0909	0.2979	-0.1360	
December	-0.1536	0.1617	0.0246	-0.2870	
Av. monthly volatility	0.1464	0.0890	0.3777	0.1605	0.2913
Annualized Volatility	0.5071	0.3083	1.3083	0.5558	1.0092

Source: Own research based on stocks data

Table 10 indicates that, the year 2021 had the highest number of months with negative stock returns while the year with the highest number of positive stock returns was 2020.

Figure 10 CRBP stock volatility
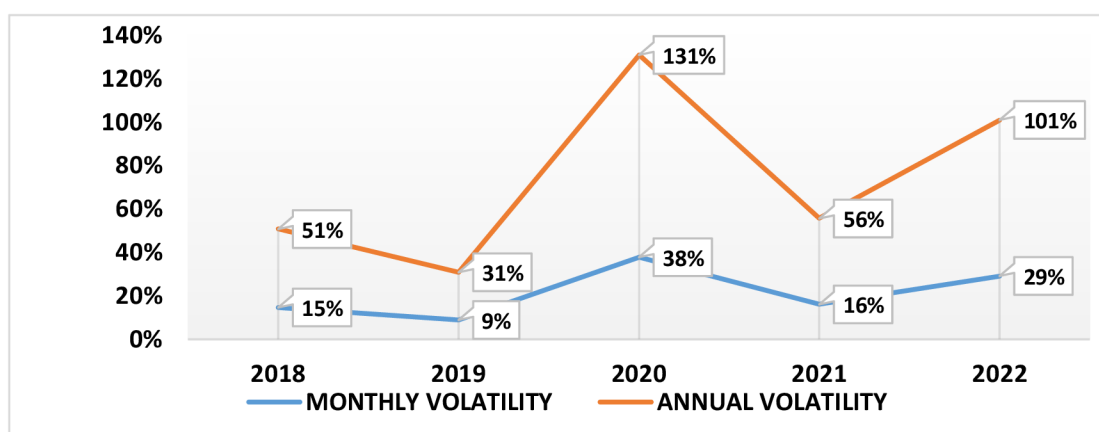
Source: Own research based on stocks data

Figure 10 shows that CRBP had the highest monthly volatility in 2020 at a rate of 38%, while least volatility was in 2019 at a rate of 9%. The highest annual volatility was in 2020 at a rate of 131%, while least volatility was in 2019 at a rate of 31%.

Neptune Wellness Inc (NEPT)

Table 11 NEPT monthly stock returns

	2018	2019	2020	2021	2022
January					
February	-0.2870	0.0772	-0.1224	-0.1124	0.2813
March	0.1660	-0.1212	-0.4375	-0.1709	-0.4634
April	-0.0214	0.2821	0.7863	0.0076	-0.2273
May	0.0182	0.0122	0.4258	-0.0379	-0.0588
June	0.1071	0.0507	-0.0604	-0.0787	-0.7500
July	-0.0774	0.3149	-0.0036	-0.3077	-0.1857
August	0.4126	-0.2955	-0.0143	-0.1975	0.8772
September	-0.0396	-0.1166	-0.2327	-0.0769	
October	-0.0309	-0.0562	-0.0853	-0.1500	
November	-0.1489	-0.1399	-0.0933	-0.0196	
December	-0.2062	-0.0484	-0.1086	-0.1800	
Av. monthly volatility	*0.1909*	0.1811	0.3304	*0.0922*	*0.5285*
Annualized Volatility	*0.6614*	*0.6273*	*1.1445*	*0.3195*	*1.8307*

Source: Own research based on stocks data

Table 11 indicates that the highest number of months with negative stock returns was in 2021 while the highest number of months with positive return was in 2018.

Figure 11 NEPT stock volatility
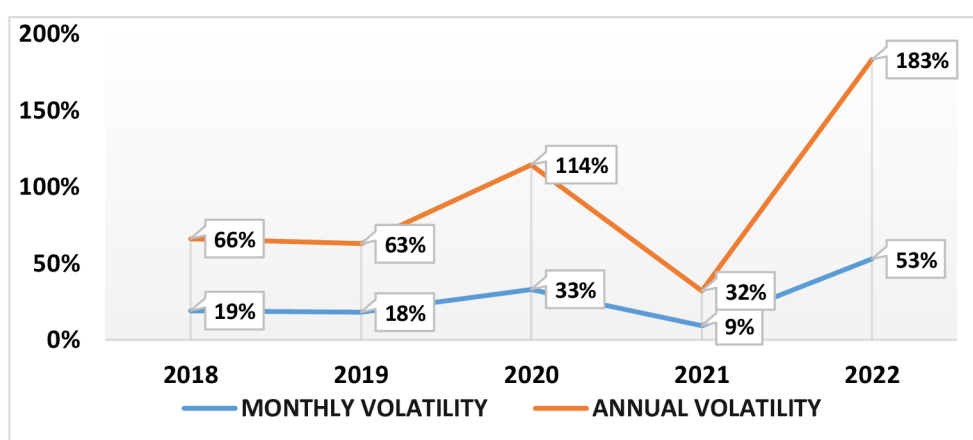
Source: Own research based on stocks data

Figure 11 shows NEPT had the highest monthly volatility in first 8 months of 2022 at a rate of 53%, while the lowest monthly volatility was in 2019 at a rate of 18%. The highest annual volatility was in 2022 at a rate of 183%, while the least annual volatility was in 2019 at a rate of 63%.

4.2 Comparative Analysis of Volatility

4.2.1 Monthly Volatility

Table 12 Lowest and highest monthly volatility

Company	Highest (%)	Year	Lowest (%)	Year
TRSSF	30	2020	9	2019
CARA	20	2021	10	2020
ACB	67	2020	9	2021
CGC	28	2018	7	2021
CODI	21	2020	7	2021
XXII	40	2020	15	2022
APDN	137	2022	15	2021
IIPR	19	2019	8	2021
CRBP	38	2020	9	2019
NEPT	53	2022	9	2021
Average Percentage	45.3		9.8	

Source: Own research based on stocks data

Table 12 above shows that the year 2020 had the highest number of companies record high monthly volatility rates with rates ranging from 19% to 137%, while low monthly volatility rates were recorded in 2021, with rates ranging from 7% to 15%. The monthly lowest average volatility for the five years (2018-2022) is 9.8%, while the monthly highest average volatility is 45.3%.

4.2.2 Annualized Volatility

Figure 12 Annualized Volatility

Annualized Volatility

	TRSSF	CARA	ACB	CGC	CODI	XXII	APDN	IIPR	CRBP	NEPT
2018	0.9784	0.6187	0.7554	0.9675	0.2767	0.5336	0.7783	0.6234	0.5071	0.6614
2019	0.3181	0.6272	0.5114	0.4699	0.2725	0.816	0.9047	0.6599	0.3083	0.6273
2020	1.0489	0.3391	2.3302	0.8072	0.727	1.3789	1.0394	0.4719	1.3083	1.1445
2021	0.4751	0.6808	0.2985	0.2373	0.242	0.7595	0.5179	0.2729	0.5558	0.3195
2022	0.6084	0.5763	0.7239	0.8967	0.2946	0.5132	4.745	0.408	1.0092	1.8307

■ 2018   ■ 2019   ■ 2020   ■ 2021   ■ 2022

Source: Own research based on stocks data

Figure 12 shows that a majority of the companies recorded high annual volatility changes in 2020 while the low annual volatility was recorded in 2021. Applied DNA recorded the highest overall yearly volatility rates while CARA, CODI and IIPR the lowest on average.

4.3 Financial Ratios and Stock Volatility of Cannabis Biotech Stocks

4.3.1 Correlation and Regression analysis results per company

In this section, both correlation and regression analysis will be used. Linear correlation analysis is a technique for representing the proximity of one variable to another. A perfect negative correlation is represented by a correlation of -1, 0 while a perfect positive correlation is represented by a correlation of 1, 0. A positive relationship is indicated by a correlation coefficient that is greater than or equal to zero, while a negative relationship is indicated by a correlation coefficient that is less than or equal to zero.

Regression analysis is a collection of statistical techniques is used to ascertain the connections between a dependent variable and a set of independent variables. It predicts how these variables will interact in the future and evaluates how strong the relationship is between them. This is shown by the multiple R^2 value, which indicates how much of the variation in the dependent variable can be explained by the independent variable. An R^2 of 1 indicates that the data were correctly predicted by the regression predictions. A positive coefficient shows a direct correlation among the variables, whereas a negative coefficient denotes the opposite. The dependent variable will decrease as the independent variable increases and vice versa if the coefficient has a negative value. Tables with the outcomes of the correlation and regression analyses were generated for interpretation and conclusions. ANOVA and residuals are computed and explained in order to demonstrate correlations between variables or their absence as well as the significance of the models utilized.

TerrAscend (TRSSF)

Table 13 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	0.085121455	1			
P/E Ratio	-0.363028089	0.529445769	1		
Return on Equity	-0.441090365	0.739394767	0.430396031	1	
Working Capital Ratio	-0.245397968	0.250831384	-0.293784578	0.29228163	1

Source: Own research based on stocks data

The only positive correlation is between the EPS and Stock Volatility, while there is negative correlation between P/E ratio, Return on Equity, Working Capital Ration and Stock Volatility of TRSSF (Table 13).

Table 14 Regression analysis

Regression Statistics

Multiple R	**0.982343181**
R Square	0.964998125
Adjusted R Square	0.824990626
Standard Error	0.12293111
Observations	6

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.96596053	0.11935174	8.093393233	0.078262536
Earnings per share (EPS)	**0.709313305**	0.16175327	4.385155992	0.142735261
P/E Ratio	*-0.001802973*	0.00055208	-3.265754356	0.189166727
Return on Equity	*-0.000798928*	0.00025329	-3.154181838	0.195451864
Working Capital Ratio	*-0.013639676*	0.00554842	-2.458300834	0.245952847

Source: Own research based on stocks data

Table 14 indicates that the independent variables EPS, P/E ratio, ROE, and working capital ratio explain 98% of the variation of the dependent variable (stock volatility of TRSSF). The results also indicate that there is a positive relationship between EPS and TRSSF stock volatility. This indicates that while other factors remain constant, EPS leads to a 0.709 percent positive change in the TRSSF stock volatility. There is a negative relationship between P/E ratio, ROE, working capital ratio, and TRSSF stock volatility. This shows that while other factors remain constant, the P/E ratio, ROE, and working capital ratio cause a negative change of 0.0018, 0.0008, and 0.0136 respectively in the variation of the TRSSF.

Table 15 ANOVA Results

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.768	4	.692	.318	.849[b]
	Residual	2.176	1	2.176		
	Total	4.944	5			

Source: Own research based on stocks data

The regression sum of squares and residual sum of squares are 2.768 and 2.176, respectively. This indicates that the model explains 2.768 variability in the stock volatility, while it doesn't explain 2.176 variability in the stock volatility, which is the dependent variable. Table 15 shows that the independent variables are not significant in explaining the variation in the dependent variable, as indicated by the F-statistic value of 0.318, which is

less than 1. Furthermore, these variations and differencing are also indicated in Table 16 below by minimum, maximum, and mean values.

Table 16 Residual Results

Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.134652	1.937530	1.074817	.7440003	6
Residual	-.8671067	1.0824703	.0000000	.6596739	6
Std. Predicted Value	-1.264	1.160	.000	1.000	6
Std. Residual	-.588	.734	.000	.447	6

a. Dependent Variable: Annualized Volatility

Source: Own research based on stock data

Table 16 indicates that, despite the small variations, the model is a good fit to the data and that the predicted values are similar to the observed values on average, as shown by the value of the mean, which ranges close to zero.

Cara Therapeutics (CARA)

Table 17 Correlation Results

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	-0.792635982	1			
P/E Ratio	-0.842883604	0.90117702	1		
Return on Equity	-0.60395326	0.95298829	0.828624615	1	
Working Capital Ratio	-0.544330171	0.58805713	0.389701124	0.5230032	1

Source: Own research based on stocks data

The results in Table 18 indicate there is a negative correlation between all variables and CARA stock volatility.

Table 18 Regression analysis

Regression Statistics

Multiple R	0.962698329
R Square	0.926788072
Adjusted R Square	0.633940361
Standard Error	0.075467719
Observations	6

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.59371492	0.292232681	2.031651347	0.291187696
Earnings per share (EPS)	*-0.198763944*	0.187848648	-1.058106862	0.482030985
P/E Ratio	*-0.000944357*	0.001161865	-0.81279391	0.565511101
Return on Equity	*0.005775983*	0.003965757	1.456464208	0.383036332
Working Capital Ratio	*-0.006398818*	0.014682564	-0.435810649	0.738354611

Source: Own research based on stocks data

Table 18 shows that financial ratios (an independent variable) explain 96% of the variation in CARA stock volatility. The results also indicate that EPS, P/E ratio, and working capital ratio exhibit a negative change in stock volatility with values of 0.1988, 0.0009, and 0.0064, respectively, while other factors remain constant. ROE causes a positive change in the CARA stock volatility by a value of 0.0058 while other factors remain constant.

Table 19 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.068	4	.017	5.707	.303[b]
	Residual	.003	1	.003		
	Total	.071	5			

Source: Own research based on stock data

According to Table 19, the regression model is significant, and the F-statistic value of 5.707 indicates that the model's independent variables account for a significant amount of the variation in the dependent variable.

Table 20 below shows the model is a good fit to the data and that the predicted values are similar to the observed values on average, as shown by the value of the mean, which ranges close to zero (0.000-0.5706).

Table 20 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.3391	.6519	.5706	.11697	6
Residual	-.02472	.02955	.00000	.02448	6
Std. Predicted Value	-1.979	.695	.000	1.000	6
Std. Residual	-.452	.540	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research based on stock data

Aurora Cannabis Holdings (ACB)

Table 21 Correlation Results

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	-0.932073484	1			
P/E Ratio	0.152349452	0.04862425	1		
Return on Equity	-0.524225791	0.61955855	0.002882	1	
Working Capital Ratio	0.379233792	-0.5601239	0.215945	-0.73289	1

Source: Own research based on stocks data

There is negative correlation between EPS, ROE and ACB stock volatility while there is positive between P/E ratio and working capital ratio and ACB stock volatility (Table 21).

Table 22 Regression analysis

Regression Statistics

Multiple R	0.987174252
R Square	0.974513004
Adjusted R Square	0.872565022
Standard Error	0.263185128
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.399131813	0.60141075	2.326416368	0.25844713
Earnings per share (EPS)	-0.082548515	0.016070781	-5.136559055	0.122407808
P/E Ratio	0.005981649	0.003506096	1.706071259	0.33751509
Return on Equity	-0.002156494	0.003759797	-0.57356662	0.668476186
Working Capital Ratio	-0.268928613	0.173837201	-1.547014164	0.365320997

Source: Own research based on stocks data

Table 22 shows that the financial ratios influence 98% of the variation in ACB stock volatility. The results also indicate that while other factors remain constant, EPS, ROE, and working capital ratio cause a negative change of 0.0825, 0.0021, and 0.2689, respectively, in the variation of ACB stock volatility. The P/E ratio causes a positive change in ACB stock volatility by 0.0060 while other factors remain constant.

Table 23 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.564	4	.641	6.135	.293[b]
	Residual	.104	1	.104		
	Total	2.668	5			

Source: Own research from stock data

Table 23 indicates the value of the F-statistic is 6.135, the regression mean square is 0.641, and the value of the residual mean square is 0.104, implying the regression model is significant and the independent variables in the model are explaining a significant amount of the variation in the dependent variable.

Table 24 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.3907	2.3097	.8788	.71609	6
Residual	-.21857	.20821	.00000	.14456	6
Std. Predicted Value	-.682	1.998	.000	1.000	6
Std. Residual	-.676	.644	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 24 indicates smaller variations in the relations to the predicted value of the dependent variable. In addition, the mean value is close to zero, suggesting that the regression model is a good fit to the data and that the predicted values are similar to the observed values on average.

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Canopy Growth Corporation (CGC)

Table 25 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity (%)	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	0.48860669	1			
P/E Ratio	-	-	1		
Return on Equity (%)	-0.413659403	-0.2451825	-	1	
Working Capital Ratio	0.127224144	0.47775642	-	0.588835	1

Source: Own research based on stocks data

Note: The blank section, is a result of absence of values for the respective ratios.

Table 25 indicates that, there a positive correlation between EPS, working capital ratio and CGC stock volatility while a negative correlation between ROE and CGC stock volatility.

Table 26 Regression analysis

Regression Statistics

Multiple R	0.941042861
R Square	0.885561666
Adjusted R Square	0.427808329
Standard Error	0.221376556
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.234769766	0.682869295	0.343798978	0.789189806
Earnings per share (EPS)	0.019896704	0.116474581	0.17082443	0.892289459
P/E Ratio	0	0	65535	0
Return on Equity (%)	-0.006746072	0.006291592	-1.07223609	0
Working Capital Ratio	0.027516209	0.039943187	0.688883656	0.615974207

Source: Own research based on stocks data

Table 26 indicates that financial ratios influence 94% of the variability of CGC stock volatility. The results also indicate that EPS and working capital ratio, while other factors remain constant, cause a positive change of 0.0199 and 0.0275, respectively, in the variability of CGC stock volatility. ROE causes a negative change of 0.0067 in the variability of CGC stock volatility while other factors remain constant.

42

Table 27 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.188	3	.063	.635	.659[b]
	Residual	.198	2	.099		
	Total	.386	5			

Source: Own research from stock data

Table 27 indicates the regression mean square, residual mean square, and F-statistic values are 0.063, 0.099, and 0.635. This implies that independent variables provide little to no significant variations in the dependent variable since the F-statistic is less than 1.

Table 28 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.4126	.8704	.6762	.19400	6
Residual	-.17526	.32069	.00000	.19882	6
Std. Predicted Value	-1.359	1.001	.000	1.000	6
Std. Residual	-.557	1.020	.000	.632	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 28 indicates that despite the little to no significant variations and differences provided by the independent variables, the model is a good fit to the data and that the predicted values are similar to the observed values on average.

Compass Diversified (CODI)

Table 29 Correlation Results

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	*-0.375319064*	1			
P/E Ratio	*-0.571144765*	0.45410393	1		
Return on Equity	*-0.24353669*	0.98879678	0.364343	1	
Working Capital Ratio	*-0.603833076*	0.63944086	0.766081	0.5909605	1

Source: Own research based on stocks data

Table 29 shows that the financial ratios have a negative correlation with the CODI stock volatility.

Table 30 Regression analysis

Regression Statistics	
Multiple R	*0.999766244*
R Square	0.999532542
Adjusted R Square	0.99766271
Standard Error	0.008857737
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.051005844	0.052421418	20.04916849	0.031726635
Earnings per share (EPS)	*-0.818955298*	0.022982823	-35.63336455	0.017861146
P/E Ratio	0.003009286	0.000209233	14.3824476	0.044192538
Return on Equity	0.07563929	0.002100118	36.01668896	0.017671149
Working Capital Ratio	*-0.294792853*	0.01894496	-15.56048999	0.040856395

Source: Own research based on stocks data

Table 30 shows that financial ratios influence 99.9 % of the variability of CODI stock volatility. The results indicate that EPS and the working capital ratio cause a negative change of 0.8189 and 0.2948, respectively, while other factors remain constant. P/E ratio and ROE cause a positive change of 0.0030 and 0.0756, respectively, in the variability of CODI stock volatility.

Table 31 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.178	4	.044	10.284	.229[b]
	Residual	.004	1	.004		
	Total	.182	5			

Source: Own research from stock data

The F-statistic value of 10.284, which is greater than one and greater than the regression mean square and residual mean square, shows the significance of this regression model and the independent variables' ability to explain a sizable portion of the variation in the dependent variable, as shown in Table 31.

Table 32 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.2300	.7217	.3407	.18842	6
Residual	-.04501	.04667	.00000	.02938	6
Std. Predicted Value	-.587	2.022	.000	1.000	6
Std. Residual	-.685	.710	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 32 shows the mean value is zero or remarkably close to zero, therefore this model is a good fit to the data, and the predicted values of the dependent variable are similar to the observed values on average.

22nd Century Group (XXII)

Table 33 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	0.005343569	1			
P/E Ratio	-0.205397548	0.096644	1		
Return on Equity	-0.167137931	0.916051	0.350762	1	
Working Capital Ratio	-0.53560268	0.6633	-0.1655	0.617588	1

Source: Own research based on stocks data

Table 33 shows that there is a negative correlation between P/E ratio, ROE, and working capital ratio and XXII stock volatility while there is positive correlation between EPS and XXII stock volatility.

Table 34 Regression analysis

Regression Statistics				
Multiple R	0.859034717			
R Square	0.737940645			
Adjusted R Square	-0.310296777			
Standard Error	0.397997441			
Observations	6			

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.735177066	0.950160474	1.826193695	0.318939352
Earnings per share (EPS)	5.636443785	7.697299279	0.732262522	0.597623109
P/E Ratio	-0.015008206	0.03286229	-0.456699942	0.727264697
Return on Equity	-0.01119556	0.045972386	-0.243527933	0.847925484
Working Capital Ratio	-0.076552089	0.053129643	-1.440854559	0.386243419

Source: Own research based on stocks data

Table 34 shows that the financial ratios explain 85% of the change in the variation of XXII stock volatility. The results show that EPS, P/E ratio, and working capital ratio cause individual positive changes of 5.6364, 0.0150, and 0.0766, respectively, in the variation of XXII stock volatility while other factors remain constant. ROE causes a negative change of 0.0112 in the variation of XXII stock volatility while other factors remain constant.

Table 35 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.499	4	.125	.728	.694[b]
	Residual	.171	1	.171		
	Total	.670	5			

Source: Own research from stock data

Table 35 shows that independent variables account for little to no significant variations in the dependent variable, as indicated by the value of the F-statistic (0.728), which is less than 1 but still greater than the regression mean square and residual mean square.

Table 36 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.4047	1.3039	.7228	.31591	6
Residual	-.24413	.30802	.00000	.18509	6
Std. Predicted Value	-1.007	1.840	.000	1.000	6
Std. Residual	-.590	.744	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 36 demonstrates that the regressed model is a good fit to the data despite the insignificant variations in the dependent variable, and that the average predicted values of the dependent variable are similar to the observed values.

IIPR

Table 37 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	-0.875441795	1			
P/E Ratio	-0.374960376	0.33090042	1		
Return on Equity	-0.665147763	0.90066576	0.55118106	1	
Working Capital Ratio	-0.203126475	0.32171315	0.513088879	0.3697208	1

Source: Own research based on stocks data

Table 37 results shows there is negative correlation between the IIPR stock volatility and the financial ratios.

Table 38 Regression analysis

Regression Statistics				
Multiple R	0.999336133			
R Square	0.998672707			
Adjusted R Square	0.993363535			
Standard Error	0.012772496			
Observations	6			
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.632326125	0.012921885	48.93450952	0.013007818
Earnings per share (EPS)	*-0.1503424*	0.007364353	-20.41488299	0.031159196
P/E Ratio	*-0.004235653*	0.000397235	-10.66283206	0.059530444
Return on Equity	0.070151313	0.005648851	12.41868612	0.051152685
Working Capital Ratio	0.000733884	0.000137688	5.330060819	0.118066967

Source: Own research based on stocks data

Table 38 shows that financial ratios explain 99.9 % of the variation in IIPR stock volatility. The results indicate that EPS and EPS, individually, cause a negative change of 0.1503 and 0.0042 in the variation of IIPR stock volatility while other factors remain constant. ROE and working capital ratio individually cause a positive change of 0.0702 and 0.0007 respectively in the variation of IIPR stock volatility.

Table 39 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.100	4	.025	18.753	.171[b]
	Residual	.001	1	.001		
	Total	.102	5			

Source: Own research from stock data

Table 39 indicates that the independent variables in the model are explaining a significant amount of the variation in the dependent variable, as shown by the larger value of the F-statistic (18.753), which is larger than one and greater than the regression mean square and residual mean square.

Table 40 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.2866	.6776	.4823	.14156	6
Residual	-.01773	.02061	.00000	.01635	6
Std. Predicted Value	-1.383	1.380	.000	1.000	6
Std. Residual	-.485	.564	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 40 shows that the regression model is a good fit to the data and that, on average, the estimated values of the dependent variable are similar to the observed values, in addition to the significant fluctuations and differences in the dependent variable explained by independent variables.

Corbus Pharmaceuticals (CRBP)

Table 41 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	-0.206900908	1			
P/E Ratio	0.766821696	0.351643	1		
Return on Equity	-0.394124754	0.933229	0.074779	1	
Working Capital Ratio	-0.202530676	0.663631	0.680909	0.674644	1

Source: Own research based on stocks data

Table 41 shows that there is a negative correlation between EPS, ROE, and working capital ratio and CRBP stock volatility, while there is a positive correlation between P/E ratio and CRBP stock volatility.

While Table 42 shows a negative correlation between EPS, ROE, and working capital ratio and CRBP stock volatility, whereas there is a positive correlation between P/E ratio and CRBP stock volatility. Additionally, financial ratios explain 97.8 % of the variation in CRBP stock volatility. While other factors remain constant, EPS and working capital ratio, individually, cause a negative of 2.4587 and 0.3313 in the variation of CRBP stock volatility. P/E ratio and ROE, individually, show a positive change of 0.4257 and 0.0121, respectively, in the variation of CRBP stock volatility.

49

Table 42 Regression analysis

Regression Statistics	
Multiple R	0.978413245
R Square	0.957292479
Adjusted R Square	0.786462394
Standard Error	0.194374323
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	2.818890704	0.680756313	4.140821979	0.15085397
Earnings per share (EPS)	-2.458749668	1.112825245	-2.209466113	0.270571262
P/E Ratio	0.425734718	0.113530358	3.749963678	0.165906171
Return on Equity	0.012062995	0.005414118	2.22806262	0.268572409
Working Capital Ratio	-0.331338599	0.101597188	-3.261296935	0.189410293

Source: Own research based on stocks data

Table 43 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.626	4	.156	1.453	.547[b]
	Residual	.108	1	.108		
	Total	.733	5			

Source: Own research from stock data

According to Table 43, the independent variables in the model are responsible for explaining a significant amount of the variation in the dependent variable. This is supported by the F-statistic value of 1.453, which is greater than one and equal to the regression mean square and the residual mean square.

Table 44 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.3712	1.1982	.6918	.35370	6
Residual	-.17593	.18461	.00000	.14673	6
Std. Predicted Value	-.907	1.432	.000	1.000	6
Std. Residual	-.536	.563	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 44 shows that in addition to the significant variations and differences in the dependent variable explained by independent variables, the regression model is a good fit to the data and that the predicted values of the dependent variable are similar to the observed values on average.

Neptune Wellness Solutions Inc. (NEPT)

Table 45 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	-0.050995633	1			
P/E Ratio	-0.242087297	0.664364	1		
Return on Equity	-0.493585289	0.739982	0.675976	1	
Working Capital Ratio	0.141619029	0.111602	-0.11751	-0.46871	1

Source: Own research based on stocks data

Results of Table 45 show there is a negative correlation between EPS, P/E ratio, ROE, and NEPT stock volatility, while there is a positive correlation between working capital ratio and NEPT stock volatility.

Table 46 Regression analysis

Regression Statistics	
Multiple R	0.995152418
R Square	0.990328335
Adjusted R Square	0.951641675
Standard Error	0.120167908
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	2.031416212	0.230837261	8.80020932	0.072032453
Earnings per share (EPS)	0.08726526	0.010186836	8.566473541	0.07398044
P/E Ratio	0.004410387	0.014881533	0.296366438	0.816577158
Return on Equity	-0.033288114	0.003443377	-9.667286629	0.065619611
Working Capital Ratio	-0.817957938	0.11076871	-7.384377223	0.085690424

Source: Own research based on stocks data

The results in Table 46 show that the financial ratios explain 99.5 % of the variation in NEPT stock volatility. The results indicate a negative relationship between ROE and working capital ratio and NEPT stock volatility, while there is a positive relationship between EPS and P/E ratio and NEPT stock volatility. While other factors remain constant, EPS and P/E ratio, individually, cause a positive change of 0.0872 and 0.0044, respectively, in the variation of NEPT stock volatility, while ROE and working capital ratio cause a negative change of 0.0333 and 0.818, respectively.

Table 47 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.556	4	.389	34.451	.127[b]
	Residual	.011	1	.011		
	Total	1.568	5			

Source: Own research from stock data

Table 47 indicates that the independent variables in the model are explaining a significant amount of the variation in the dependent variable, as shown by the larger value of the F-statistic (34.451), which is larger than one and greater than the regression mean square and residual mean square.

Table 48 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.3206	1.8178	.8404	.55789	6
Residual	-.07612	.06881	.00000	.04752	6
Std. Predicted Value	-.932	1.752	.000	1.000	6
Std. Residual	-.716	.648	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 48 output shows that the regressed model is a good fit to the data and that the average predicted values of the dependent variable are similar to the observed values, in addition to the significant variations and differences in the dependent variable that are explained by independent variables.

Applied DNA Science (APDN)

Table 49 Correlation analysis

	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
Stock Volatility	1				
Earnings per share (EPS)	0.491227696	1			
P/E Ratio	0.244410138	0.424065523	1		
Return on Equity	0.196252624	0.171607763	-0.62040576	1	
Working Capital Ratio	*-0.336383329*	-0.40518991	-0.1576313	-0.644588	1

Source: Own research based on stocks data

Table 49 indicates a positive correlation between EPS, P/E ratio, ROE, and APDN stock volatility, while there is a negative correlation between working capital ratio and APDN stock volatility.

Table 50 Regression analysis

Regression Statistics	
Multiple R	0.854118189
R Square	0.729517881
Adjusted R Square	-0.352410594
Standard Error	1.912303362
Observations	6

	Coefficients	Standard Error	t Stat	P-value
Intercept	12.53317056	7.725490269	1.62231394	0.351664732
Earnings per share (EPS)	*-0.418007561*	0.407298416	-1.026293119	0.491739705
P/E Ratio	12.08729084	9.217608271	1.311326158	0.414762941
Return on Equity	0.036806774	0.028106786	1.309533347	0.415182979
Working Capital Ratio	5.236672309	4.134719569	1.266512087	0.425484045

Source: Own research based on stocks data

Table 50 shows that financial ratios explain 85.4% of the variation in APDN stock volatility. The results indicate a positive relationship between P/E ratio, ROE, working capital ratio, and APDN stock volatility and a negative relationship between EPS and APDN stock volatility. The results also indicate that while other factors remain constant, P/E, ROE, and working capital ratio, individually, cause a positive change of 12.0873, 0.0368, and 5.2367 respectively, and EPS causes a negative change of 0.418 in the variation of APDN stock volatility.

Table 51 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.686	4	2.421	.655	.716[b]
	Residual	3.699	1	3.699		
	Total	13.384	5			

Source: Own research from stock data

Table 51 indicates that the independent variables provide no significant variations in the dependent variable, as indicated by the value of the F-statistics (0.655), which is less than 1 and less than the values of the regression mean square (2.421) and residual mean square (3.699).

Table 52 Residual Results

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.2326	3.9493	1.4288	1.39180	6
Residual	-1.48332	.80675	.00000	.86009	6
Std. Predicted Value	-.859	1.811	.000	1.000	6
Std. Residual	-.771	.419	.000	.447	6

a. Dependent Variable: Stock Volatility

Source: Own research from stock data

Table 52 shows the regression model might not be a good fit to the data, and the predicted values might be systematically over- or underestimating the actual values, as indicated by the mean value that ranges from 0.00 to 1.4288.

5 Results and Discussion

The aim of this study was to comparatively analyze the performance of cannabis biotech stocks of firms listed on the NYSE and NASDAQ using the historical volatility for the period from January 2018 to August 2022. The study selected ten listed companies according to their market capitalization and the period they were listed on the stock exchange market. For the firm to qualify, it had to have traded on a stock exchange for a period of at least four years.

The monthly adjusted closing stock price was used to determine the returns using the logarithmic method in Excel 2016. The returns were then used to determine the month's volatility using the standard deviation. To annualize the volatility, the monthly volatility was multiplied by the square root of 12, or the number of months traded in that year.

After determining the annual volatility, the study established the relationship and the effect of financial ratios on the stock volatility of the listed companies using correlation and regression analysis, respectively.

Financial ratios are used to analyze a company's financial performance and health, and negative financial ratios typically indicate that the company is facing financial difficulties. The study findings indicate that the majority of cannabis companies have exhibited negative financial ratios for the last 5 years. These negative values of financial ratios further indicate that, despite the positive correlation with the dependent variable (stock volatility), they have little to no significant causation in the variation of stock volatility, as indicated by the results of the regression analysis, including the ANOVA results and residual results. In addition, these findings indicate that there are other confounding factors that have a causal effect on the stock volatility of the cannabis biotech stock. Furthermore, the negative financial ratios indicated by the findings indicate that the majority of the cannabis firms have financial problems. This may be attributed to the volatility of the cannabis market, which is mostly influenced by continuous changes in rules and regulations, growth and expansion.

The findings of the study indicate that most of the listed companies had very high monthly volatility rates, averaging 45.3%, as indicated in Table 12. The lowest recorded monthly volatility averaged 9.8%. The findings indicate that the annual volatility rate is highly dependent on the monthly volatility rate. This implies that the higher the monthly volatility rates, the higher the annualized volatility rates. The findings indicate that cannabis

biotech stock had the highest annual volatility rate, averaging 156.9% for the years 2018–2021, as shown in Table 13. The lowest recorded annual volatility rate for the period of 2018 – 2022 was 33.7%.

The outcomes signify that, generally, financial ratios have a negative relationship with cannabis biotech stock volatility, as shown by the correlation results. This implies that as the value of the ratios increases, the stock volatility decreases, and the reverse is true. The study also found that the correlation coefficient values were minimal, indicating a weak relationship between the financial ratios and stock volatility. The regression analysis R^2 values ranged from 70% to 99%, showing that, on average, the sum of all financial ratios explained between 70% and 99% of the variance in cannabis biotech stock volatility. Individual coefficient values of the regression analysis indicates a weak negative and positive relationship between the individual financial ratios and cannabis biotech stock volatility.

The finds of this master's thesis study indicate that cannabis stock is highly volatile and unpredictable. The results agree with the observations made by Kazemi (2018) and Ceresna (2018), who found the cannabis stock to be very volatile. However, the authors indicate that high volatility rates can be beneficial as they provide an opportunity for translating fundamental views and implementing overriding strategies. According to Wagner (2019), a market with high volatility is more likely to experience a decline, while a market with lower volatility is more likely to experience a rise. As a result, investors can align their portfolios with the associated expected returns by utilizing this data on long-term stock market volatility.

High volatility rates, according to Boyte-White (2019), offer investors, both long-term and short-term, more opportunities to profit. In his study he says that traders who want to make money by taking advantage of volatility can use indicators like strength indices, volume, and established support and resistance levels.

According to the findings, many cannabis stocks experienced high volatility rates in 2020 and 2021. This is because of changes in marijuana-related legal reforms, which means that businesses must deal with very different sets of rules depending on where they do business. Another reason is the taxation in the cannabis industry. High and uncertain tax policies create uncertainty in the prices of marijuana products, leading to high profits or high losses.

6 Conclusion

The cannabis biotech stock is highly volatile. A higher level of stock price volatility typically indicates a higher level of risk and may aid an investor in estimating future fluctuations. Investors must understand that the regulatory environment is uncertain and that publicly traded companies within it lack successful business models and profitability, which are the two main causes of this volatility. Before investing in these stocks, investors should conduct extensive research due to the market's extreme volatility and unpredictability. This implies that investors can make high profits or losses on their investment.

The study focused on ten cannabis firms traded on NASDAQ and NYSE only. Therefore, further empirical studies can be carried out on more companies and in stock markets across the globe to better understand the stock performance of cannabis biotech stocks. The study used the standard deviation method for determining volatility, which is mainly used by investors. The study, therefore, recommends that future empirical studies use the exponentially weighted moving average (EWMA) model and histogram to determine stock volatility since they are used to describe time series.

The study recommends that future studies may focus on environmental, social, and governance ratios as well as other financial ratios and their impacts on cannabis biotech stock volatility. The study also recommends that investors conduct concrete research on a wide variety of cannabis biotech stocks before making a final investment decision. This will provide the opportunity to understand the risks involved in investing and make the right decision. Finally, investors may proceed with caution, as uncertainty makes it difficult to predict which stock may perform better or worse.

Selected period and companies: This study only analyzes a specific time period (January 2018 to August 2022), which may not be representative of the long-term performance of these specific stocks. Additionally, the study only analyzes ten selected companies and is, as such, not a representation of the whole cannabis biotech industry.

Finally, the ten companies under study indicated a varied mix of factors that drive their stocks volatility results. Some companies like TRSSF, CODI and Applied DNA have been largely stable counters while the rest demonstrated the highest swings. Factors such as over valuation, shareholder dilution, acquisition, expansion, debt, high research costs, and insufficient data have also come through the course of this ex-post factor research study.

6.1 Limitations

Historical volatility: The study uses historical volatility as a measure of stock performance, which does not cover all aspects of stock volatility.

External factors: The thesis makes no mention of any external factors, such as regulatory changes or market trends, which are known to influence stock performance.

Overall, the results may differ if other metrics were used even in the selected master's. thesis study sample. Finally, because this paper does not provide a detailed explanation of the selection criteria for the ten listed companies, the findings may not be generalizable.

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8 List of Pictures, Tables, and Abbreviations

8.1 List of Pictures

8.2 List of tables

8.3 List of Abbreviations

NYSE – New York Stock Exchange

NASDAQ – National Association of Securities Dealers Automated Quotations Stock Market

THC– tetrahydrocannabinol

CBD – cannabidiol

EPS – Earnings per share

IPO – Initial public offering

ETF – Exchange-traded funds

9 Appendix

Adjusted Closing Stock Price Data and Financial Ratios

Table 53 TerrAscend Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	2.51	6.673	2.412	12.14	5.23
February	2.37	6.094	2.252	13.41	5.63
March	3.8	5.85	1.81	10.18	5.7
April	2.608	6.1	2.175	11.09	4.655
May	2.967	5.723	2.316	11.528	4
June	3.15	5.4	2.124	11.45	2.28
July	3.178	4.877	3.2	8.1	2.36
August	4.069	4.893	4.85	7.04	1.92
September	5.042	3.81	4.32	7.04	
October	7.01	3.54	5.79	5.76	
November	5.227	2.59	9.88	6.004	
December	4.28	2.19	10.05	6.115	

Table 54 TerrAscend Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	50%	-0.12	-20.5	-19.64	31.73
2018	98%	-0.13	-33.2	-34.04	1.88
2019	32%	-1.27	-1.46	-347.37	0.64
2020	105%	-0.82	-12.4	-820.61	1.36
2021	48%	0.02	299	3.01	2.04
2022	61%	0.16	190	9.99	1.98

Table 55 Cara Therapeutics Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	14.67	15.25	16.1	18.7	11.58
February	13.98	17.05	15.03	18.35	10.37
March	12.38	19.62	13.21	21.71	12.15
April	12.38	19.08	14.82	12.95	8.72
May	15.64	20.56	15.87	13.59	8.32
June	19.15	21.5	17.1	14.27	9.13

July	17.93	23.94	16.44	11.97	8.74
August	20.17	23.44	15.5	15.78	10.32
September	23.95	18.28	12.725	15.45	
October	18.74	20.76	13.26	16.83	
November	18.18	25.98	14.67	13.18	
December	13	16.11	15.13	12.18	

Table 56 Cara Therapeutics Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	48%	-1.91	0	-70.37	11.18
2018	62%	-2.06	0	-69	4.16
2019	63%	-2.49	0	-69.71	3.86
2020	34%	0.18	189.13	4.72	10.55
2021	68%	-1.73	0	-40.55	9.84
2022	58%	-1.25	0	-31.32	8.32

Table 57 Compass Diversified Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	11.78191	11.47268	19.18001	18.31552	24.40399
February	11.89137	12.22892	15.31399	21.38519	23.25205
March	11.67775	12.19007	11.19517	20.93308	23.26184
April	11.0369	12.85047	16.7844	23.00378	21.39267
May	11.97301	12.34731	14.49836	23.80351	22.42789
June	12.59168	15.17409	14.72903	23.39073	21.18189
July	12.66446	15.24556	13.62692	22.90457	23.86177
August	13.22151	15.15529	15.27366	26.48505	20.86
September	13.48148	15.93975	16.6352	27.00726	
October	11.74337	16.69994	15.09038	28.61792	
November	11.59401	19.51765	17.39974	27.94432	
December	9.440509	20.47295	17.29305	29.66113	

Table 58 Compass Diversified Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	34%	-0.44	-33.9	-3.23	2.48
2018	28%	-0.42	-24.4	-3.48	2.63
2019	27%	3.64	6.96	40.85	3.08

69

2020	73%	-0.34	-36	2.83	2.4
2021	24%	0.73	56.26	6.66	3
2022	29%	0.9	17.42	12.17	3.37

Table 59 22nd Century Closing Stock Price

	MONTHLY CLOSING STOCK PRICE				
	Year				
Month	**2018**	**2019**	**2020**	**2021**	**2022**
January	3.41	2.24	0.927	2.5	2.17
February	2.51	2.41	0.74	3.35	2.34
March	2.35	1.71	0.75	3.29	2.32
April	2.07	2.19	0.94	4.68	1.91
May	2.12	1.91	0.828	4.5	1.82
June	2.46	2.09	0.764	4.63	2.13
July	2.5	1.59	0.792	3.21	1.68
August	2.71	1.96	0.59	3.57	1.34
September	2.81	2.26	0.641	2.96	
October	2.42	1.89	0.727	2.74	
November	3.04	1.03	1.59	2.51	
December	2.49	1.1	2.2	3.09	

Table 60 22nd Century Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	43%	-0.13	-20.385	-34.713	15.68
2018	53%	-0.06	0	-10.592	11.83
2019	82%	-0.21	-5.182	-40.75	7.39
2020	138%	-0.14	-15.267	-38.15	3.86
2021	76%	-0.21	-17.167	-38.822	6.45
2022	51%	-0.26	-6.13	-51.394	2.47

Table 61 Applied DNA Closing Stock Price

	PRICE LIST-ADJ CLOSE				
	Year				
Month	2018	2019	2020	2021	2022
January	60.8	17.6	3.79	11.14	3.3
February	58	26.8	3.99	8.95	2.56
March	57.6	28.4	4.02	7.19	2.14
April	60.4	23.6	6.88	6.87	1.6
May	59.6	23.6	9.72	5.79	1.29

June	50.4	20	8.07	6.79	0.74
July	55.2	12	10	5.38	0.71
August	48.8	12.4	7.33	5.86	3.12
September	59.6	8.8	7.73	5.39	
October	44	6.8	7.71	5.38	
November	44	4.18	7.52	5.78	
December	16	4.19	5.1	4.02	

Table 62 Applied DNA Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	51%	-19.6	-3.53	-150	5.29
2018	78%	-15.86	-1	-400	1.68
2019	90%	-9.69	-0.41	-1200	6.39
2020	104%	-3.32	-1.45	-214.29	2.24
2021	52%	-2.07	-1.84	-111.11	2.85
2022	475%	-1.45	-1.23	-152.94	2.16

Table 63 Innovative Industrial Properties Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	24.477112	54.762005	81.693893	177.8463	193.5155
February	21.384277	69.858704	83.921066	185.3358	184.015
March	22.917845	72.246582	69.307442	171.2313	200.5555
April	29.532362	75.689255	72.514572	175.3842	142.3655
May	32.499447	74.702461	75.527534	172.6068	131.0031
June	31.677656	109.844528	81.350151	182.9404	108.1797
July	28.200394	94.3927	97.489548	207.3801	96.41
August	39.539776	79.644684	115.129875	237.2057	91.72
September	42.013184	82.5121	116.083931	222.9874	
October	35.968121	68.450546	110.091583	255.4155	
November	43.303894	69.720505	145.045654	249.3381	
December	39.829052	68.333481	172.863556	255.2408	

Table 64 Innovative Industrial Properties Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	65%	-0.13	0	-0.12	11.07
2018	62%	0.75	55.39	4.012	67.83
2019	66%	2.03	35.54	6.36	59.07
2020	47%	3.27	44.64	5.756	160.59
2021	27%	4.55	55.15	7.475	52.6
2022	41%	4.93	21.84	8.012	55.21

Table 65 Aurora Cannabis Closing Stock Price

	ADJ STOCK PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	114.564	85.08	22.68	11.15	4.16
February	97.2	90.72	16.08	10.52	3.8
March	87.24	108.72	10.872	9.31	4
April	75.588	108.96	8.88	8.94	3.03
May	75	91.08	14.08	9.66	1.66
June	84.84	93.84	12.42	9.04	1.32
July	65.4	75	10.19	7.02	1.41
August	80.16	66	9.8	7.42	1.6
September	115.2	52.68	4.65	6.92	
October	81.6	43.08	4.05	6.63	
November	68.64	30	11.68	6.42	
December	59.52	25.92	8.31	5.41	

Table 66 Aurora Cannabis Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	56%	-0.45	-43.1	2.51	2.91
2018	76%	1.46	58.1	-2.28	3.31
2019	51%	-2.66	-35.3	-33.61	2.94
2020	233%	-24.85	-0.4973	-92.7	4.96
2021	30%	-3.31	-2.75	-18.92	4.92
2022	72%	-4.8	-0.26	-119.37	5.13

Table 67 Corbus Pharmaceuticals Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	7.5	7.56	6.47	1.83	0.44
February	7.4	6.94	4.74	2.18	0.346
March	6.1	6.95	5.24	1.97	0.532
April	5.95	7.14	6.48	1.8	0.339
May	6.2	7.01	7.46	2.17	0.303
June	5.05	6.93	8.39	1.83	0.252
July	5.05	6	6.27	1.37	0.253
August	5.85	5.18	9.285	1.29	0.202
September	7.55	4.87	1.8	1.02	
October	6.66	5.17	0.94	1	
November	6.9	4.7	1.22	0.864	
December	5.84	5.46	1.25	0.616	

Table 68 Corbus Pharmaceuticals Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	23%	-0.65	-1.34	-74.42	7.98
2018	51%	-0.98	-5.96	-116.67	2.45
2019	31%	-1.12	-4.83	-230.4	1.09
2020	131%	-1.42	-0.8446	-308.97	2.89
2021	56%	-0.37	-1.58	-56.96	5.89
2022	101%	-0.29	-0.51	-52.92	4.81

Table 69 Neptune Wellness Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	118.3	117.95	82.95	62.3	11.2
February	84.35	127.05	72.8	55.3	14.35
March	98.35	111.65	40.95	45.85	7.7
April	96.25	143.15	73.15	46.2	5.95
May	98	144.9	104.3	44.45	5.6
June	108.5	152.25	98	40.95	1.4
July	100.1	200.2	97.65	28.35	1.14
August	141.4	141.05	96.25	22.75	2.14
September	135.8	124.6	73.85	21	
October	131.6	117.6	67.55	17.85	
November	112	101.15	61.25	17.5	
December	88.9	96.25	54.6	14.35	

Table 70 Neptune Wellness Financial Ratios

Year	Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017	57%	0	3.183	0	1.9
2018	66%	4.62	12.85	0	2.21
2019	63%	-5.7	-0.4221	-31.9	2.3
2020	114%	-11.84	-0.0685	-102.33	4.01
2021	32%	-30.32	-0.035	-71.04	1.75
2022	183%	-15.56	-0.09	-76.31	1.7

Table 71 Canopy Growth Closing Stock Price

	ADJ CLOSING PRICE				
	Year				
Month	2018	2019	2020	2021	2022
January	25.203	48.98	22.55	40.07	8.04
February	21.32	47.41	18.78	32.75	7.12
March	26.123	43.37	14.42	32.03	7.58
April	23.44	50.52	16	26.95	5.71
May	28.37	40.26	17.37	26.09	4.97
June	29.29	40.31	16.16	24.18	2.85
July	26.33	32.64	18.28	18.91	2.63
August	45.72	23.58	16.52	17.23	3.68
September	48.64	22.93	14.32	13.86	
October	36.89	19.96	18.78	12.63	

November	33.55	18.59	28.8	10.71	
December	26.87	21.09	24.64	8.73	

Table 72 Canopy Growth Financial Ratios

Year		Stock Volatility	Earnings per share (EPS)	P/E Ratio	Return on Equity	Working Capital Ratio
2017		68%	-0.11	0	-3.22	12.8
2018		97%	-0.31	0	-14.36	17.85
2019		47%	-1.96	0	-34.55	7.59
2020		81%	-2.86	0	-12.47	6.24
2021		24%	-3.56	0	-9.5	8.31
2022		90%	-0.62	0	-81.02	3.94