The University of New Haven

Department of Economics

Senior Thesis

May, 2021

The Impact of Covid-19 on Technology Equities

Matthew P. Liscio

Advisor: Brian A. Marks, J.D., Ph.D.

University of New Haven

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Section I: Introduction

Historically pandemics have resounding impacts. The impacts they have on us as a society can be seen from something as small as people washing their hands. Impacts can also be seen in much greater magnitudes such as being the cause of recessions. While the reactions of politicians and the public vary in each pandemic we must learn from each pandemic and apply that knowledge in the future to better protect us against infectious diseases. If anything is for sure, we know that Covid-19 will end one day, and then there will be a new infectious disease after it. If we learn from this coronavirus, the next infectious disease should not impact society on the scale Covid-19 has done. According to Cutler and Summers (2020), Covid-19 will cost the nation $19 trillion as calculated by total GDP loss and total health loss if the pandemic ends by Fall 2021.[1] Calculations of health loss include premature death, long-term health impairment, and mental health impairment.

With the Coronavirus pandemic still an ongoing event in our society as of this writing, there are very few empirical studies done on the financial and societal effects it will leave.

This study looks to examine the impacts Covid-19 had on major technology equities and how they affected the stock prices of each company studied. In particular, this paper will focus on three major technology companies; Apple, Amazon, and Zoom. It is expected to see that Covid-19 had a statistically significant impact on the stock valuations of the three companies studied.

This paper proceeds as follows. Section II reviews the literature with the following foci: (1) the validity of event studies and (2) the Capital Asset Pricing Model (CAPM), its usefulness, and its

[1] https://news.harvard.edu/gazette/story/2020/11/what-might-covid-cost-the-u-s-experts-eye-16-trillion/

application to the study of worldwide pandemics, and (3) the Capital Asset Pricing Model and its application to the food sector of the Covid-19 economy. Section III walks through and breaks down the data. Section IV discusses the methodology of the CAPM model used. Section V analyzes the results found. Section VI concludes the paper discusses potential possibilities for future research. Section VII is the bibliography.

Section II: Literature Review

The studies reviewed in this section have three foci. The first focus is the validity of event studies. The second focuses on the Capital Asset Pricing Model, its usefulness and, its application to event study analysis. The third focus is the Capital Asset Pricing Model applied to a different sector of the Covid-19 economy.

Khotari and Warner's study is titled “Econometrics of Event Studies”. In this paper, they discuss the purpose and validity of event studies. In financial economics, event studies are used to be able to properly test market efficiency. When there are systematically nonzero security returns persisting over a period after a shock to the system, we know those returns are not consistent with the overall market efficiency.[2] For this paper "a shock to the system” is defined as an event that may or may not have a significant impact on the valuations of companies. When conducting an event study it must be set up in such a way that yields the most accurate results. This study was conducted following all the proper methods. These methods include but are not limited to the use of daily security returns.[3]

[2] “Econometrics of Event Studies”
[3] “Econometrics of Event Studies”

In a study done by Hoehler and Lansink titled "Measuring the impact of COVID-19 on stock prices and profits in the food supply chain," the authors evaluate the impact Covid-19 had on the food supply chain using the capital asset pricing model in R Studio.

Pandemic event studies present a unique problem in conducting research. Pandemics do not occur on a singular day. They occur over an extended period that can last years. When Hoehler and Lansink conducted their research, they broke down the Coronavirus pandemic into various stages. These stages included: Incubation, Outbreak, Fever, and Below Peak. As you will see in the data section, this paper follows the same timeline.

To gauge how much of a toll the pandemic has had on financial markets Cutler and Summers performed a study titled "The Covid-19 Pandemic and the $16 Trillion Virus". Closures due to social distancing guidelines have put many people out of work. For 20 weeks beginning in late March 2020, new unemployment claims exceeded 1 million per week.[4] As any economist knows, nothing happens in isolation, there almost always downstream effects. This was evident when real GDP fell by $2,227.28 billion from Q4 2019 to Q2 2020.[5] It can also be seen in the stock prices of the companies studied in this paper.

In a paper by Jagannathan and McGrattan titled "The CAPM Debate," the authors break down the capital asset pricing model. The most commonly used version of the CAPM is the one developed by Sharpe (1964) and Lintner (1965). This model has been proven to be successful at evaluating the risk of cash flows from a potential investment project and establishing the project's cost of capital.[6] In 1992, Fama and French debunked this model and essentially rendered it useless. Their study claims that beta has no role in explaining cross-sectional variation in returns, that size has an important role, and that the book-to-market equity ratio has an important role.[7] Even with the contention over the validity of CAPM, it is proven that if the

[4] https://jamanetwork.com/journals/jama/fullarticle/2771764

[5] https://fred.stlouisfed.org/series/GDP

[6] http://www.sfu.ca/~kkasa/jagannat.pdf

[7] http://www.sfu.ca/~kkasa/jagannat.pdf

period is long enough, CAPM will be able to, at the minimum, partially explain relationships such as return and beta.[8]

Section III: Data

This study examines Covid-19 on three international technology companies. All data in this study is taken from Yahoo! Finance. For purposes of this study, we will consider January 2nd, 2020 will be the first day in the first dummy variable. The year before Covid-19 (2019) will be considered the control group. From January 2nd, 2020 and on periods are broken up into several parts following the relevant Covid-19 situation. The different periods are as follows:

1. Incubation: January 2nd – January 17th
2. Outbreak: January 20th – February 21st
3. Fever: February 24th – March 20th
4. Below peak: March 23rd – April 29th

When running the regression in R Studio, each period was run together and every day within each respective period was given a "1". This process ensured that each day was considered a dummy variable.

The companies being studied are Apple, Amazon, and Zoom. These three companies were chosen for various reasons. Firstly, they are all large-cap technology companies listed on the NASDAQ. Secondly, they were picked because of their unique market position relative to each other. Apple is an international designer, manufacturer, and retailer of smartphones, laptops, tablets, and wearables.[9] Amazon is a major internet-based corporation that sells books, music,

[8] http://www.sfu.ca/~kkasa/jagannat.pdf
[9] https://money.cnn.com/quote/profile/profile.html?symb=AAPL

movies, housewares, electronics, toys, and many other goods, either directly or as the middleman between other retailers and Amazon's millions of customers.[10] Amazon also has a web service arm called AWS and its purpose is to rent data storage and perform computing resources, so-called "cloud computing," over the Internet.[11] Zoom is a software company that offers a communications platform that connects people through video, voice, chat, and content sharing.[12]

The stock prices used are daily, end of day, stock prices of Apple, Amazon, Zoom. Also, the daily price quote of the NASDAQ, Dow Jones, and S&P 500 are also included. The date range used is from April 18, 2019, to April 1, 2021. All prices are denominated in US dollars.

Section IV: Methodology

This paper is an event study analysis using CAPM to evaluate the impact of the Covid-19 pandemic on stock prices. The CAPM equation is a linear regression model. The model uses historical returns to calculate its results. Historical returns are a common strategy for analysts to forecast future stock prices.

The study demanded an individual equation for each company studied therefore, multiple equations were used. This made it possible to evaluate the statistical significance of each coefficient. In addition to testing for the coefficient for each company, this paper also evaluates the NASDAQ coefficient and its effect on each company.

[10] https://www.britannica.com/topic/Amazoncom

[11] https://www.britannica.com/topic/Amazoncom

[12] https://www.crunchbase.com/organization/zoom-video-communications

Dummy variables are used to differentiate “Covid days" and "Normal days". The pandemic, for this paper, is broken up into different periods that correspond to different stages of the pandemic. Every day within the specified period is given a 1 and is considered a dummy. Every other day will be given a 0. Each date will be spelled out in R code individually. Each period will be run individually. If a period is not the subject of the code, all dates will be given a 0. Running the code is how we can narrow down the focus to different groups of dates.

Below are linear regression equations using the Capital Asset Pricing Model:

1. $Apple = \beta 0 + \beta 1 index + \beta 2\ Covid\text{-}19\ Dummy_A + Dummy_B + Dummy_C + Dummy_D + \varepsilon$
2. $Amazon = \beta 0 + \beta 1 index + \beta 2\ Covid\text{-}19\ Dummy_A + Dummy_B + Dummy_C + Dummy_D + \varepsilon$
3. $Zoom = \beta 0 + \beta 1 index + \beta 2\ Covid\text{-}19\ Dummy_A + Dummy_B + Dummy_C + Dummy_D + \varepsilon$

These equations will test to see if Covid-19 had a statistically significant impact on the stock prices of the three companies being studied, Apple, Zoom, and Amazon. There will also be variations of each one of these equations for each index. I.e. there will be an equation for Apple regressed against the NASDAQ and an equation regressed against the Dow Jones. This study will also bear attention to the return variable of each index. This test will clarify how statistically significant the returns are to each company. All tests will be conducted in R Studio. The time horizon studied, including dummies and not dummies is April 18, 2019 – April 1, 2021. This time frame is limited because Zoom had its initial public offering on March 22, 2019, and the earliest Yahoo! Finance has stock price data for the company is April 18, 2019.

This study hypothesizes that the major indices and dummy variables are statistically significant and are positively correlated. It is also hypothesized the technology companies will have a greater rate of return than the market due to the increased demand for various technology products caused by the pandemic.

Section V: Results

Figure 1 is the log daily returns of the Nasdaq for April 18, 2019 – April 1, 2021.

Figure 1

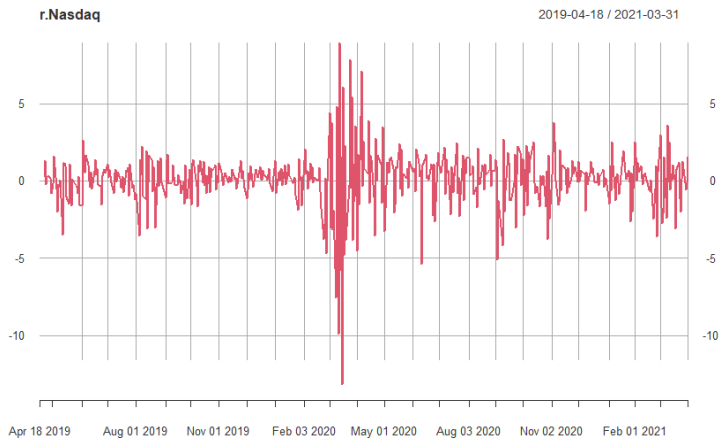


Figure 2 is the log daily returns of the Dow Jones for April 18, 2019 – April 1, 2021.

Figure 2

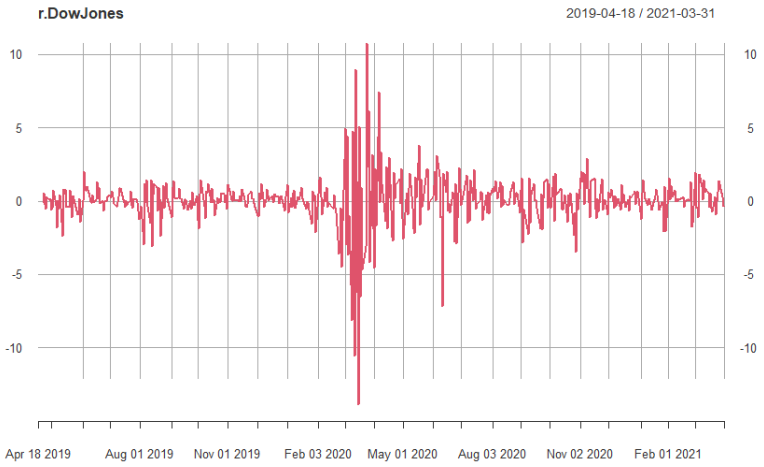


Figure 3 is the log daily returns of the S&P 500 for April 18, 2019 – April 1, 2021.

Figure 3

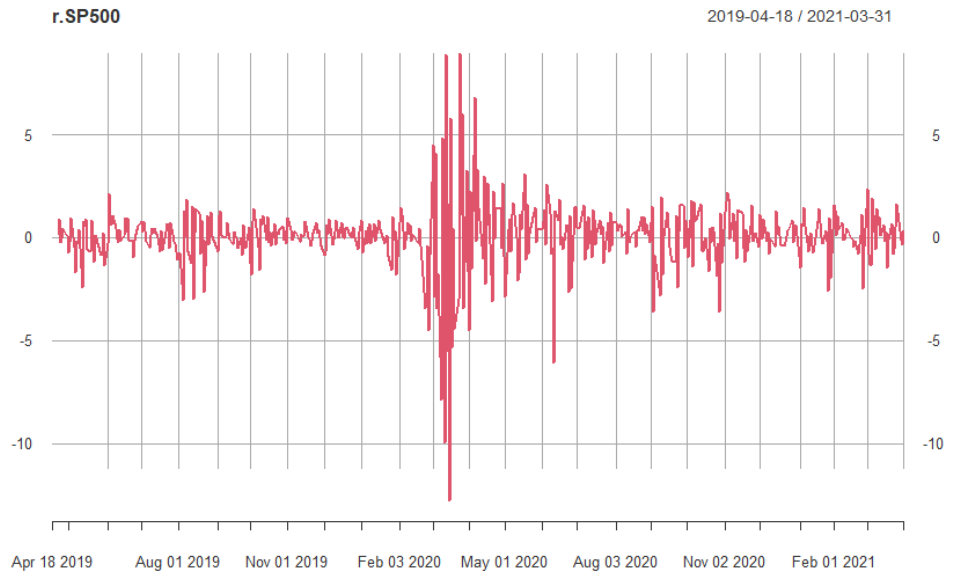


Figure 4 is the log daily stock returns for Apple from April 18, 2019 – April 1, 2021.

Figure 4

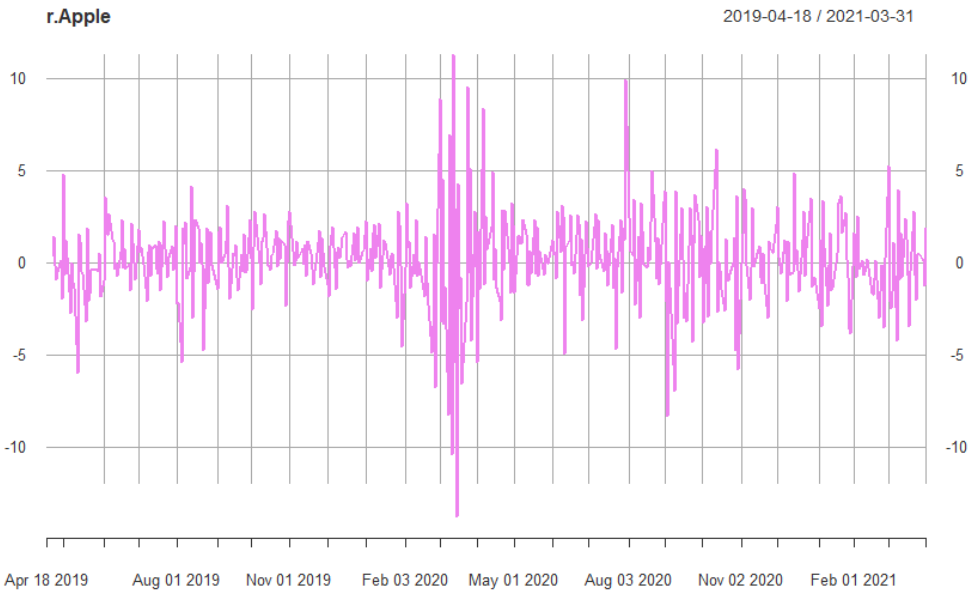


Figure 3 is the log daily stock returns for Amazon from April 18, 2019 – April 1, 2021.

Figure 3

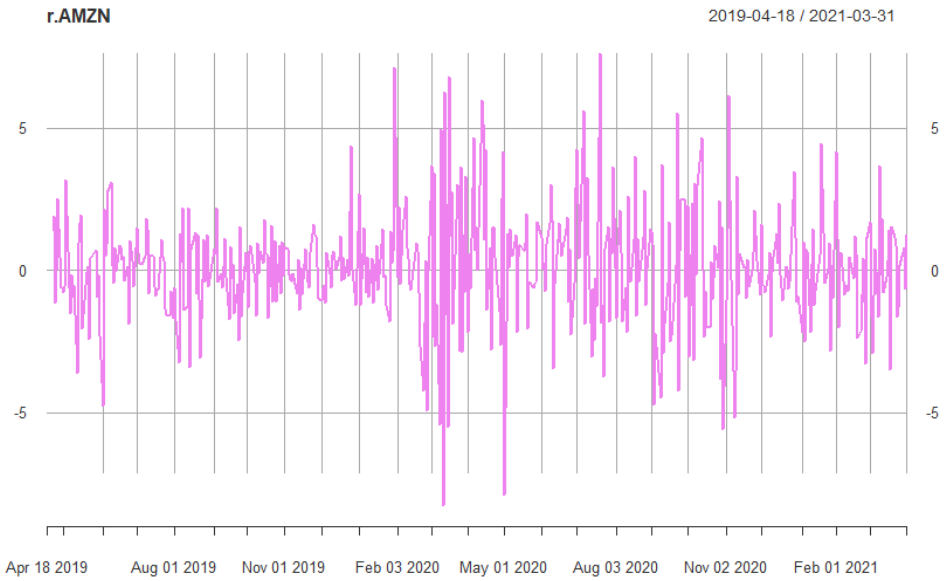


Figure 4 is the log daily stock returns for Zoom from April 18, 2019 – April 1, 2021.

Figure 4

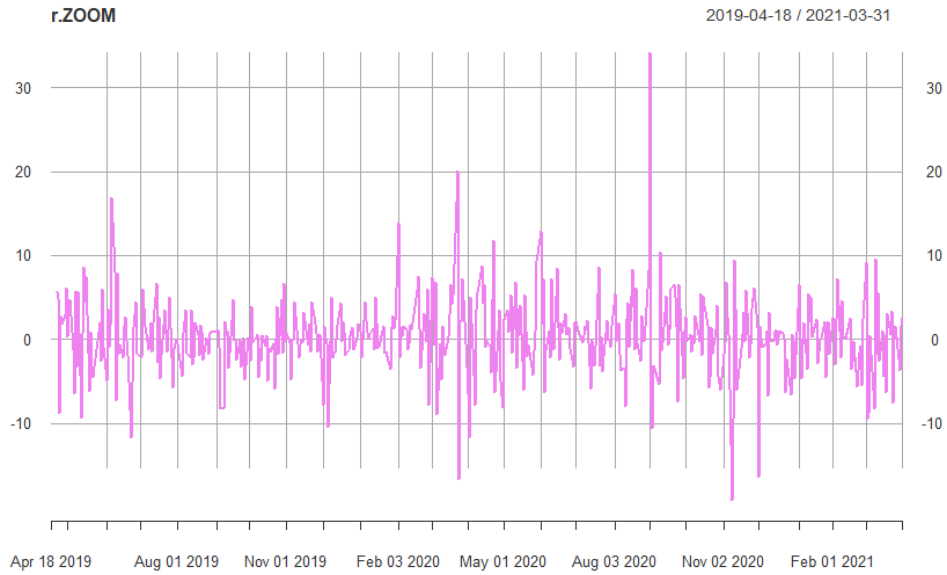


Table 1 is the stargazer summary results for all entities regressed against the Nasdaq. Dummies A, B, C, and D represent “Incubation”, “Fever”, “Outbreak”, and “Below Peak” respectively.

Table 1

	Dependent variable:		
	AAPL (1)	AMZN (2)	ZM (3)
X.IXIC	1.180***	0.858***	0.514***
	(0.031)	(0.033)	(0.117)
dummyA	0.161	-0.204	0.529
	(0.349)	(0.376)	(1.330)
dummyB	-0.245	0.479*	1.100
	(0.255)	(0.275)	(0.971)
dummyC	0.319	0.828***	1.950*
	(0.278)	(0.300)	(1.060)
dummyD	-0.367	0.150	-0.217
	(0.238)	(0.257)	(0.905)
Constant	0.076	-0.044	0.151
	(0.059)	(0.064)	(0.224)
Observations	491	491	491
R2	0.760	0.588	0.043
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 2 is the stargazer summary results for all entities regressed against the Dow Jones Industrial Average. Dummies A, B, C, and D represent “Incubation”, “Fever”, “Outbreak”, and “Below Peak” respectively.

Table 2

	Dependent variable:		
	AAPL (1)	AMZN (2)	ZM (3)
X.DJI	1.020***	0.588***	-0.147
	(0.044)	(0.046)	(0.123)
dummyA	0.313	-0.068	0.694
	(0.482)	(0.502)	(1.350)
dummyB	-0.145	0.532	1.070
	(0.353)	(0.367)	(0.988)
dummyC	0.425	0.573	0.729
	(0.389)	(0.404)	(1.090)
dummyD	-0.239	0.377	0.348
	(0.329)	(0.343)	(0.922)
Constant	0.131	0.007	0.214
	(0.082)	(0.085)	(0.228)
Observations	490	490	490
R2	0.542	0.268	0.008
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 3 is the stargazer summary results for all entities regressed against the S&P 500. Dummies A, B, C, and D represent “Incubation”, “Fever”, “Outbreak”, and “Below Peak” respectively.

Table 3

	Dependent variable:		
	AAPL	AMZN	ZM
	(1)	(2)	(3)
X.GSPC	1.180***	0.757***	0.089
	(0.040)	(0.044)	(0.129)
dummyA	0.282	-0.099	0.659
	(0.424)	(0.456)	(1.350)
dummyB	-0.186	0.516	1.100
	(0.310)	(0.334)	(0.989)
dummyC	0.518	0.783**	1.220
	(0.340)	(0.367)	(1.090)
dummyD	-0.325	0.263	0.154
	(0.289)	(0.311)	(0.923)
Constant	0.106	-0.016	0.192
	(0.072)	(0.077)	(0.229)
Observations	490	490	490
R2	0.647	0.395	0.006
Note:	*p<0.1;	**p<0.05;	***p<0.01

Figure 5 is the daily Apple stock price charted from April 18, 2019 – April 1, 2021.

Figure 5

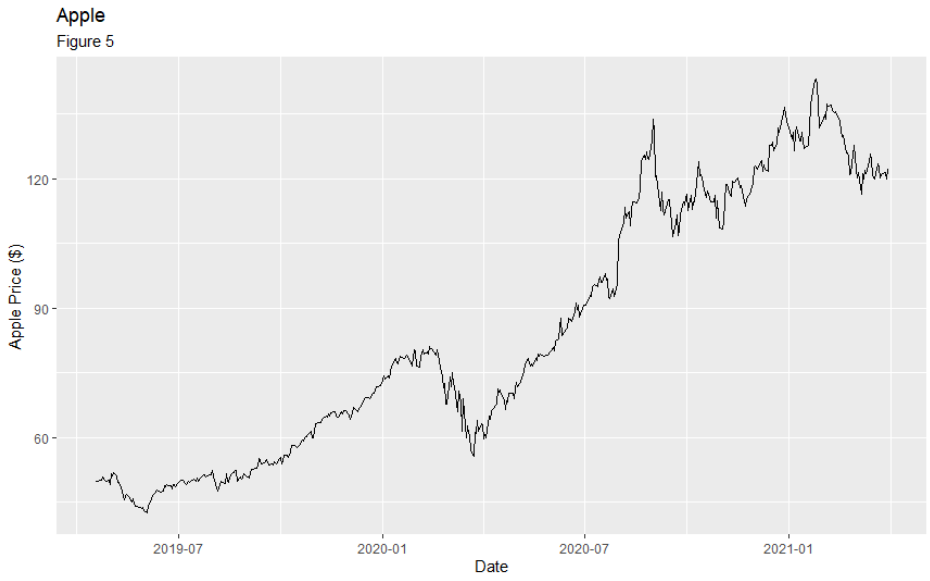


Figure 6 is the daily Zoom stock price charted from April 18, 2019 – April 1, 2021.

Figure 6

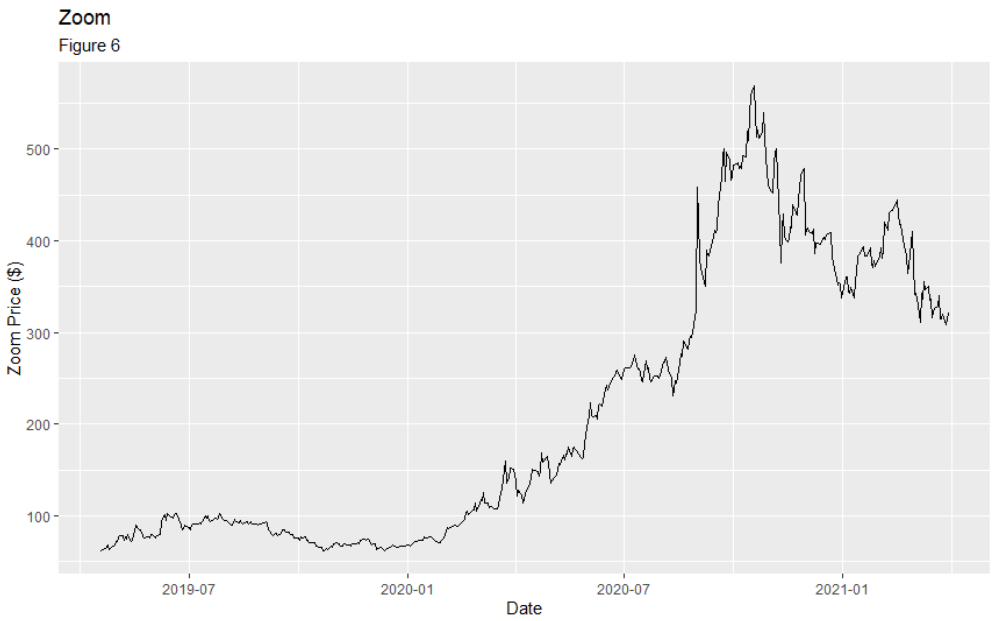


Figure 7 is the daily Amazon stock price charted from April 18, 2019 – April 1, 2021.

Figure 7

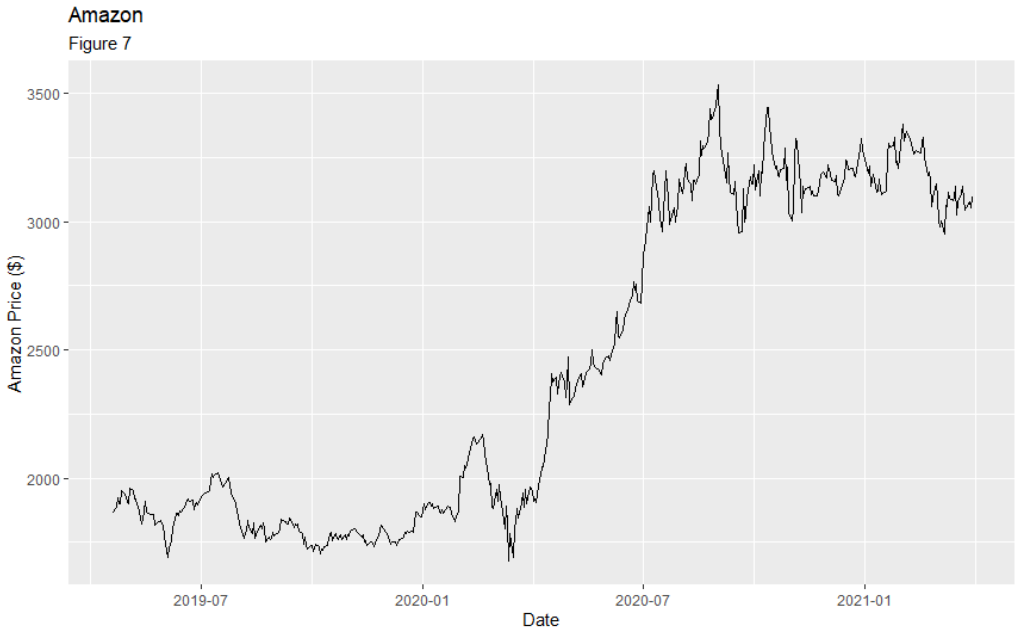


Figure 8 is the daily Nasdaq pricings charted from April 18, 2019 – April 1, 2021.

Figure 8

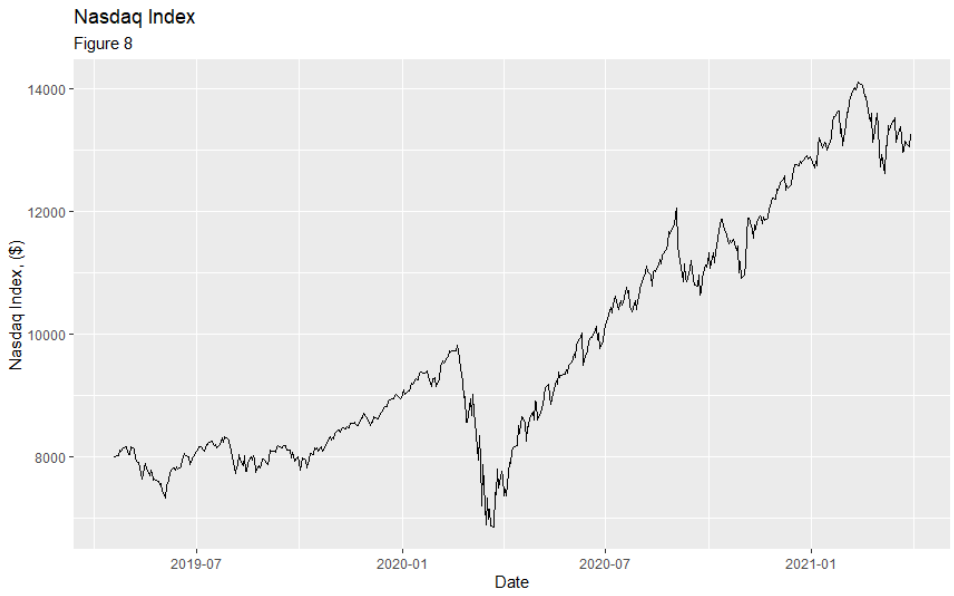


Figure 9 is the daily S&P 500 pricings charted from April 18, 2019 – April 1, 2021.

Figure 9

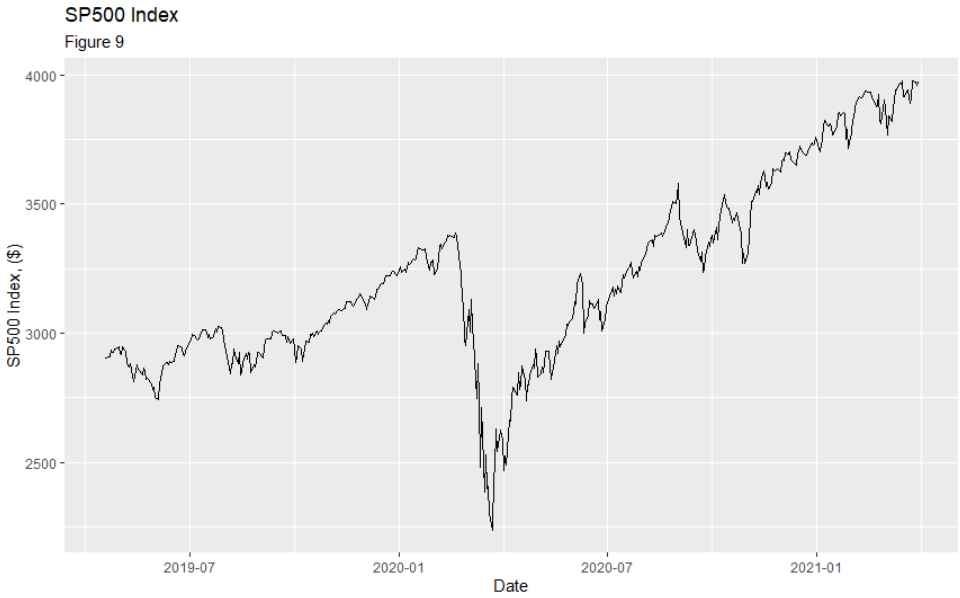
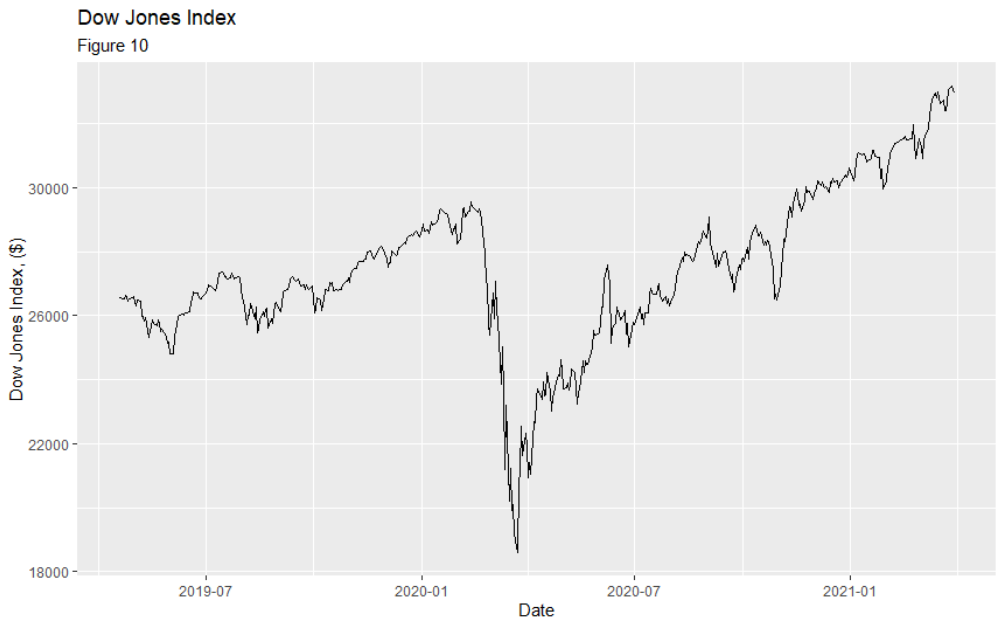


Figure 10 is the daily Dow Jones pricings charted from April 18, 2019 – April 1, 2021.

Figure 10



Section VI: Conclusion

According to the results of this paper, the pandemic did not have a large statistically significant impact on the stock prices of Apple, Zoom, and Amazon thus, the hypothesis is rejected. Although, if the tests are looked at separately, Amazon did have a statistical significance during two dummy periods.

Amazon had a statistical significance of less than 1% in one of the tests. This test was run from February 24, 2020 – March 20, 2020 and had a coefficient of 0.828. In this instance, the R2 value was 0.588. This tells us that from February 24, 2020 – March 20, 2020, 58% of the observed variation can be explained by the model with a high degree of certainty due to the P-value being

less than 0.01. This may not be an accurate result because Amazon makes up a significant portion of the Nasdaq. Therefore, I conducted the same test against the S&P 500 and the Dow Jones.

For the same period against the S&P500 the R2 value was 0.395 and the dummyC coefficient was 0.783 at significance level of less than 5%. Against the Dow Jones there was no observed statistical significance in any test. Amazon was a strong performing company last year and these tests imply that Amazon's performance is more in line with companies that rely heavily on technology based on the fact that the S&P 500 and Nasdaq are more tech heavy than the Dow Jones Industrial Average.

The Amazon result is logical because of the circumstances of the period. February 24, 2020 – March 20, 2020, is when lockdowns were first put into place by the federal and state governments. We see a dip in early March that can be explained by the uncertainty in the markets. With uncertainty, many customers may not have purchased as many products on Amazon that they otherwise would've. By the time lockdowns are officially put in place, we see a steep increase in the stock price. This can be explained by many businesses shutting down, decreased capacity in stores, and the fear of being exposed to Covid – 19 while physically shopping. All these factors together increased online shopping.

Zoom had a statistical significance of more than 10% in every test. This result tells us that the stock does not move in tandem with the Nasdaq, Dow Jones, or S&P 500. This can be seen visually by looking at figure 6 and figure 8. There we see that the movements of Zoom and the Nasdaq do not appear to move in tandem either. This can also be seen statistically when looking at the dummy variable coefficients. Zoom's dummy coefficients range from -0.217, signifying an inverse relationship, to 1.95. A 1.95 dummy beta tells us Zoom's returns were almost 2x what the market return was.

This can be explained by the business model of Zoom and how Covid-19 impacted Zoom differently from the rest of the market. The stock market crash in early March had zero impact on Zoom's stock price. Zoom benefited when there was negative news released regarding Covid-19. As social distancing rules were put in place, there was an increasing amount of people hosting meetings online rather than in person and vice versa. When the pandemic is officially over, I expect to see an increased number of online meetings as compared to pre-Covid-19 but, less than during the pandemic.

Apple also had a statistical significance of more than 10% in every test. In each test, the dummy coefficient was very low, dummyB and dummyD repeatedly had negative betas. A negative beta means the security has an inverse relationship with the index. DummyA and dummyC repeatedly resulted in betas lower than 1 and larger than 0. A beta less than 1 tells us the security is less risky than the market. A consistent low dummy coefficient tells investors that this asset is safer compared to the overall market. There are a couple of explanations as to why Apple is considered a safer asset in terms of this paper. First, Apple is the oldest company of the three studied, and secondly, Apple is well established and has a tight grip on the personal computing and cell phone industry.

With the pandemic still an ongoing event as of this writing, this topic is ripe for more research. As more information comes to light, we will be able to more clearly see the impact Covid – 19 and the related public health measures had on the global economy and the global community. To expand on this study in future research, I recommend expanding the study to more than three companies and expanding the periods studied. As the pandemic goes on, we will be able to see in hindsight each stage. This will make it easier to distinguish the progression. As the dates on the

dummy variables change with the new periods, I expect future research will find different results. I expect those results to have low P – values, ideally less than 0.05.

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