Evaluating differing financial impacts of the Covid-19 pandemic on Europe and America

Theo Delettre (21262281), Albertas Ovodas (21268870)

School of Computing, Dublin City University, Ireland

theo.delettre2@mail.dcu.ie, albertas.ovodas2@mail.dcu.ie

Abstract—COVID-19 has had a massive influence on everyone's lives, some more than others and even seen alarming increases in suicide rates during the pandemic. It didn't just affect the individual lives of the working person but also governments and markets as a whole. Governments can be handled differently, as everyone has seen during these scary days; however, the stock market cannot be predicted or dealt with that easily. COVID-19 caused huge lockdowns and placed a halt on many industries. Index funds like the EURO STOXX 50 and Dow Jones Industrial Average experienced a massive stock market crash which will go down in history like the wall street crash, and black Monday did. Upon exploration there were clear signs of stock volatility between EURO STOXX 50 in 2020 (daily standard deviation = 2.01%) and DJIA 2020 (daily standard deviation = 2.32%). Furthermore While the effects of covid 19 can be seen in the stock there is no direct correlation between covid 19 cases and the stock market fluctuations during the year 2020 as a whole not just February through march where we saw a dip of up to 36% per cent in the respected markets.

Index Terms—COVID-19, EURO STOXX 50, Dow Jones Industrial Average (DJIA), Volatility, Standard deviation, Correlation

INTRODUCTION

The first outbreak of the Covid-19 virus occurred in Wuhan, China in December 2019. Since then, the virus steadily spread all over the world, reaching USA in January 2020 and Ireland in late February 2020. The World Health Organisation declared Covid-19 a pandemic on the 11th of March 2020 [4].

The effects of this Pandemic have been felt in nearly all aspects of society over the following months. We will focus, in this paper, on the Financial repercussions.

Financially speaking, different countries were hit with varying levels of severity. The reason behind this were manifold. Of course, countries with higher incidence rates tended to suffer greater consequences, but evaluating the effect of the pandemic on an economy's performance was more complicated than that. Some financial sectors suffered greater losses than others. The tourism industry for instance was one that was particularly impacted by the pandemic as countries went into lockdown and borders closed one by one [10].

Other industries felt less of an impact from the societal effects of the pandemic. The food and grocery delivery services even thrived as countries went into lockdown and people had to stay inside their homes [10].

The industry distribution of a country isn't the only defining factor and a lot of it has to do with cultural circumstances, healthcare system, and the government's response. Evaluating all the potential influences goes much beyond the reach of this paper, we are only setting out to measure and evaluate the macro economical repercussions.

RELATED WORKS

The main concerns when writing this paper are the effects of COVID-19 in selected demographic areas and how those particular regions or their respected stock markets reacted. SARS-CoV-2 or Covid 19 is a wrapped single-stranded positive strain of big RBA that infect humans and animals [8], this devastating virus caused over 100 countries to be locked down or partially locked down in March 2020 [1]. The complete analysis of COVID-19 is unnecessary since we are interested in the market due to COVID-19, not COVID-19 itself; however, the general numbers of affected people are essential. In America, approximately 4.5 per cent of people were affected by the virus in 2020 [5], while in Europe, by late 2020, there was an approximate 2.6 per cent of cases [14], a significant difference. Covid-19 issues should relate to how much the markets crashed during the year 2020. Different stock markets have other sectors that ultimately control their worth; these sectors could create fluctuation in the market when a worldwide pandemic hits. The Dow Jones Industrial has 22.5 per cent Information Technology, and in second at 16.9

percent the health care, a complete list can be found in the reference [12] while the EURO Stoxx 50 has 17.3 per cent in Technology and healthcare coming in 6th with 7.5 percent [2]. According to Statista, in 2020, the Dow Jones Industrial Average saw its highest decrease of 34.7 percent in February and March of 2020 [7] compared to EURO Stoxx 50 at 33.5 per cent [14], which was surprising as there are almost twice as many cases in the US. Furthermore, the analysis on many markets has been done discussing the effects, and percentage dropped from COVID-19 with some also analysing how quickly the market will recover using statistical approaches [6] even though this paper is somewhat correct on the recovery predictions the market recovered a lot faster than predicted as we see now in late 2021.

DATASET AND EXPLORATORY ANALYSIS

A. Data Sources

Measuring Covid-19's impact on an economy requires estimates for both the general performance of the economy and Covid's influence over the area.

A solid benchmark indicator for the US economy is the Dow Jones Industrial Average which provides a representation of the 30 blue-chip stocks that top their respective industries [11]. For its European Counterpart we selected the EURO STOXX 50 which does a similar task in representing European Supersector leaders [15]. These indicators can be used as barometers for general market trends

As for Covid indicators, we can use CDC daily cases data for the United States [3]. In Europe, the ECDC has many missing values for our desired time frame, as such we use data from Our World in Data, which regroups data from many sources worldwide [9]. We of course make sure to exclude countries outside the Eurozone in order to match EURO STOXX 50 countries.

B. Data Exploration

The first date in which daily cases metrics are available for all 19 countries of the Eurozone is the 8th of march 2020. As such we take it as our start-date for all of our datasets. We use data from this date until the end of 2020 as this is where we will see the clearest impact since the market has had time to adapt in 2021. When running tests on the data, we also need to ensure we remove covid test data for days we do not have any stock data and vice-versa.

Plotting the daily Euro Area Covid cases for our chosen time period (fig.1) shows a lot of fluctuation, with the number of cases spiking every 7 days. This
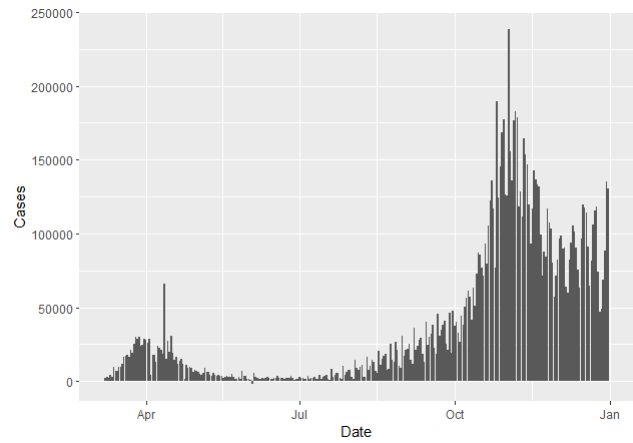

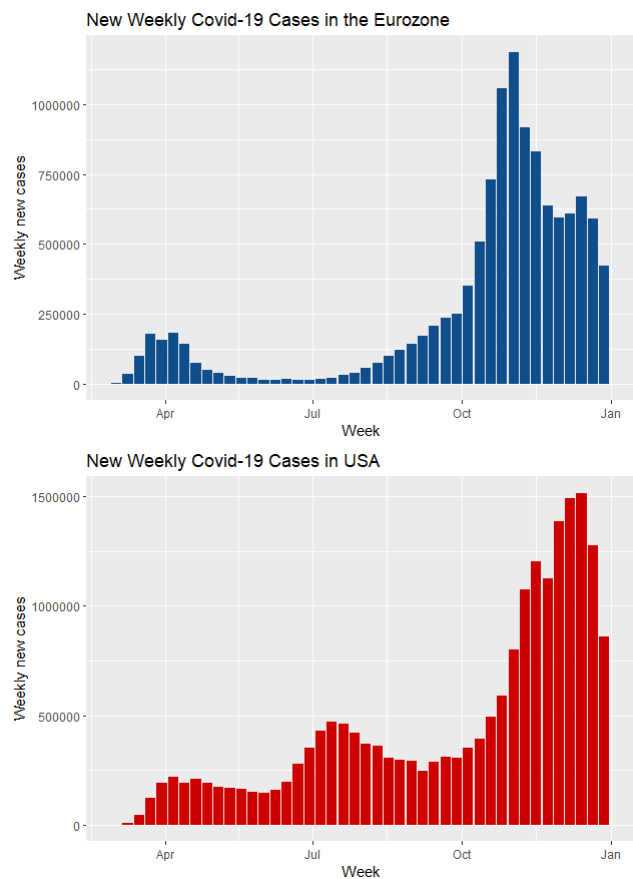Fig. 1. Daily Eurozone Covid Cases

Fig. 2. Weekly Covid Cases in Eurozone (top) and USA (bottom)

is most likely due to the amount of tests actually being carried out, with most people going to get tested when they are free on weekends. To clarify our visualization, we can instead plot the weekly cases for both regions and get a better idea

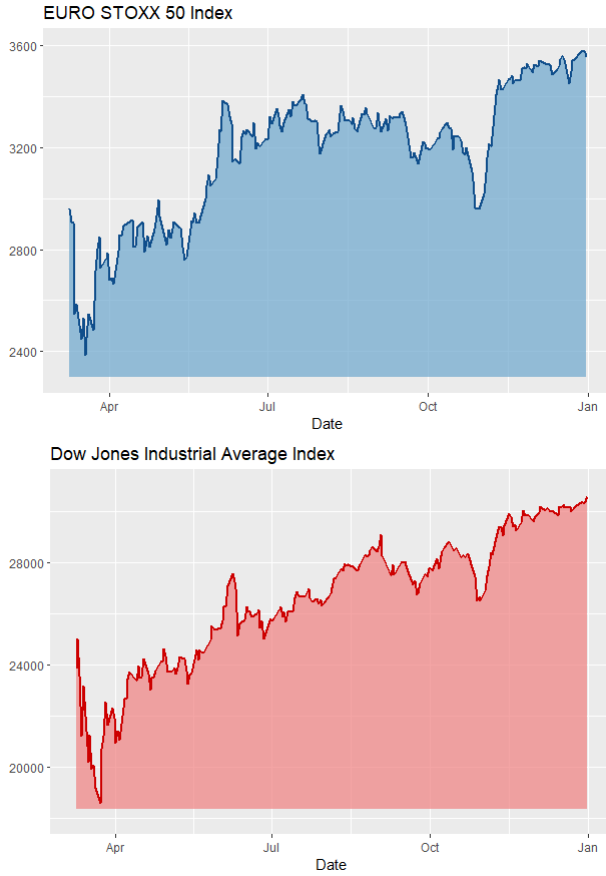The US and EU both faced a first wave in March and

Fig. 3. EURO STOXX 50 (top) and Dow Jones Industrial Average (bottom)

April of 2020 (fig.2). While the EU recovered from the first wave with low figures in May and June, the US had to face a second wave starting in late may. The EU then had to deal with its second wave, peaking in late October, before USA's third wave, which peaked in mid-December.

The total population of each area is relatively similar, with 323.5 million for the US and 342.4 in the Euro area. Hence, the 'Cases per million' index is also somewhat higher in the US than it is in the Eurozone.

As we have discussed earlier in the paper, Both economies suffered a great crash at the very start of the pandemic. The economy then started recovering over the course of 2020 (fig.3) The Stock indicators for each region look much more similar than its Covid cases. However, each indicator has its distinct characteristics, such as EURO STOXX 50 having a deeper crash in October. Dow Jones' increase is also more linear than EURO STOXX 50's. Actually evaluating the pandemic's economical impact requires further analysis.

HYPOTHESES

- **Volatility** Null Hypothesis There is no change from 2019 and 2020 EURO STOXX 50, and for DJIA volatility; otherwise, there is a significant change in volatility and investors risk increased.
- **T-Test** Null Hypothesis There is no statistical change from 2019 to 2020 for both EURO STOXX 50 and DIJA. There is no statistical significance between EURO STOXX 50 in 2020 and DJIA in 2020. Otherwise, the null hypothesis fails, and there are statistical changes.
- **Skew Normality** The Skewness of the daily mean gain will be normal (-0.5 and 0.5), Else the skeness will be high (-1 or greater than 1)
- **Correlation** Hypothesis: USA's economy has felt a stronger effect from the pandemic and thus its stock index will have a higher negative correlation with its daily covid test cases than its european counterpart. The null hypothesis would be that USA-r <= EU-r.

METHOD

A. Volatility Testing

Volatility is a very important aspect in stock especially index funds that are considered 'safe'. standard deviation is a simple way to test the volatility of a stock, Using R the variance was calculated using :

$$\sigma^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2 \tag{1}$$

Where N = Total sample number, x_i = initial value and $\overline{x}$ = mean

To find the sample standard deviation the square root of the variance is taken as seen below.

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2} \tag{2}$$

The same variable are used as mentioned in Eq(1)

If the results are not equal or close to equal the null hypothesis will fail. Even though this is a relatively simple test a lot of data had to be cleaned and processed to find the means in percentages and as a whole. Further more beta can also be used to determine the volatility of a stock, this value is widely available online on compared to standard deviation so we chose to leave it out.

B. The T test

The T test compares two groups of data, using the means it tests for discrepancies. For our case we will be looking at the t and p values to check if the null hypothesis will succeed

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} \tag{3}$$

Where $\bar{x}$ and μ = means values, s = standard deviation differences between the two data sets and n = sample size (note: if using varied formula n-1 = degrees of freedom)

C. Skew Normality

Skewness is a measure of how symmetric a curve is, for our instance we wanted to see if the symmetry persisted from 2019 compared to 2020 in relation to earnings.

$$Skew = 3 * \frac{\mu - \bar{x}}{s} \tag{4}$$

Where μ = mean, $\bar{x}$ = median and s = standard deviation

D. Correlation

Correlation measures the strength of the relationship between two variables. In our case, a strong positive correlation would mean the stock index rises as positive Covid case rise, while a negative one would mean the index falls with rising cases. We use the Pearson Correlation Coefficient:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{5}$$

x and y are our two variables and $\bar{x}$ and $\bar{y}$ are their means.

RESULTS

A. Volatility Testing and Skewness

When calculating how volatile a stock is we first found that the average mean percent gain was 0.08% at 2019 for DJIA and 0.05% in 2020, for the Euro STOXX 50 the average mean percent gain was 0.09% in 2020 and negative 0.01%. A probability distribution graph was then made to calculate the standard distribution and Skewness .The standard deviations varied from 2.32% to and a low of 0.78% this shows large changes between years and stocks which rejects the null hypothesis also the skewness was calculated and results are shown figure 4. The skewness from the DIJA 2020 graph was -1.01 which clearly states its no where near being symmetrical

Variables	Mean	Median	Standard deviation as %	Skewness	Varience
DIJA 2019	26379.58	26407.79	0.78%	-0.35	1160719.45
DIJA 2020	26890.67	26890.67	2.32%	1.01	6304203.22
EURO STOXX 50 2019	3433.99	3442.95	0.81%	-0.25	32046.07
EURO STOXX 50 2020	3275.61	3293.71	2.01%	-0.29	102055.47

Fig. 4.   Calculated Mean,Median,Standard deviation, variance and Skewness

Variables	T value	P value
DIJA 2019 compared to 2020	3.16	1.77E-03
EURO STOXX 2019 compared to 2020	6.26	1.62E-09
DIJA compared to EURO STOXX 2019	166.34	1.23E-259

Fig. 5.   Calculated T and P values using the T test

while the others ranging from -0.35 to -0.25 show fairly symmetrical daily gains average.

During this the kurosis was also found however we chose not to include it since it had low priority due to relevance.

Similarly the r value was also left out as the results seems to be flawed given r values of 0.05% which is alot lower then expected when correlating the stocks.

B. T-Test

For the T test we had results for the differences from DJIA comparing 2019 to 2020 (t = 3.16, p = 1.77E-3), EURO STOXX 50 2019 comparing 2020 (t = 6.26, p = 1.62E-9) and also DJIA compared to EURO STOXX 50 in 2020 (t = 166.34, p= 1.23E-259) as seen in figure 5. The all of the p values are clearly not over 0.05 which shows that the null hypothesis fails and there are significant statistical differences in all of these.

C. Correlation

The resulting correlation coefficients can be seen in Table 1. The results here fail to reject the null hypothesis. Finding positive correlations here, even a strong positive correlation for USA, is unexpected, but can be explained. The stock market is based a lot on expectations. Stocks are therefore more likely to crash just before a new wave of covid cases, and then rise back just as the case rise up, resulting in a seemingly positive correlation.

Further analysis would be needed to truly evaluate the nature of the relationship between the stock market and positive Covid-19 tests using different testing approaches.

	Corr. Coeff.
EUROSTOXX 50 & Eurozone Daily Covid Cases	0.3655
Dow Jones & USA Daily Covid Cases	0.7258

TABLE 1
CORRELATION COEFFICIENT BETWEEN STOCK INDICES AND COVID CASES

CONCLUSION

To conclude the relationships of stocks (EURO STOXX 50 and DJIA) in the years 2019 and 2020 were investigated with respect to COVID-19 and other correlations which included volatility, skewness, T tests and correlations.

The stocks became a lot more volatile es specially in the DJIA stock going from in 0.78 percent standard deviation in 2019 to 2.32 percent in 2020. The average daily returns also showed a large skewness in DIJA in 2020 of 1.01 however surprisingly the EUROSTOXX 50 in 2020 had a relativly regular skewness for daily gains percentages of -0.29, this could have been due to the diffrent sectors being hit in the stocks or that the European market recovered faster. The correlation tests failed to show decisive results and further tests are needed to evaluate the full direct impact of the virus.

By deepening our understanding of how the external factor of a world pandemic has affected different world economies, we are now equipped to predict the repercussions of such an event in the future.

Further work that can be done on this paper could include gathering more stock markets in europe which may include FTSE 100 and DAX; and S&P 500 and Nasdaq Composite in the united states. The industry leaders are better equipped to adapt to great societal change than smaller businesses, and these might help us reach a more comprehensive understanding. Furthermore the Asian markets could be added since the virus started in that region though it was controlled very well.

Another aspect that could be investigated in relation to COVID-19 and the stock markets recovery could be the roll out of vaccines in different regions of the world.

REFERENCES

[1] BBC, 2020. Coronavirus: The world in lockdown in maps and charts, London: BBC.

[2] BLUE-CHIP INDICES EURO STOXX 50® INDEX, 2021. BLUE-CHIP INDICE EURO STOXX 50® INDEX, Europe: stoxx.

[3] CDC (2020). COVID Data Tracker. [online] Centers for Disease Control and Prevention. Available at: https://covid.cdc.gov/covid-data-tracker/trendsdailycases.

[4] Cucinotta, D. and Vanelli, M., 2020. WHO declares COVID-19 a pandemic. Acta Bio Medica: Atenei Parmensis, 91(1), p.157.

[5] Elfein, J., 2021. Cumulative cases of COVID-19 in the U.S. from Jan 20, 2020 - Nov. 22, 2021, by day, USA: Statista.

[6] Koijen, N. J. G. a. R. S. J., 2020. The Review of Asset Pricing Studies, Volume 10, s.l.: Ox.

[7] Market Watch, 2021. Market Watch. [Online] Available at: https://www.marketwatch.com/investing/index/djia [Accessed 30 11 2021].

[8] Meyer, T. P. V. a. C. G., 2020. The COVID-19 epidemic, USA: NCBI,PubMed,John Wiley & Sons Ltd.

[9] Our World in Data, covid-19-data (2021), github repository, https://github.com/owid/covid-19-data

[10] Ozili, P.K. and Arun, T., 2020. Spillover of COVID-19: impact on the Global Economy. Available at SSRN 3562570.

[11] S&P Dow Jones Indices LLC, Dow Jones Industrial Average [DJIA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/DJIA, November 30, 2021.

[12] spglobal, 2021. Dow Jones Industrial Average®. [Online] Available at: https://www.spglobal.com/spdji/en/indices/equity/dow-jones-industrial-average/data [Accessed 30 11 2021].

[13] Statista Research Department, 2021. Number of new coronavirus (COVID-19) cases in Europe from January 26, 2020 to November 21, 2021, by date of report, Europe: Statista.

[14] Statista Research Department, 2021. Performance of the Euro Stoxx 50 index as week end value from January 2020 to November 2021, Europe: Statista.

[15] Wall Street Journal (2021). SX5E | EURO STOXX 50 Index Historical Prices - WSJ. [online] www.wsj.com. Available at: https://www.wsj.com/market-data/quotes/index/XX/SX5E/historical-prices [Accessed 1 Dec. 2021].

APPENDIX

Tools used -

Excel - Data Cleaning

R - Data cleaning, processing & exploration

Overleaf, LaTeX - Used to work simultaneously on the paper.