Reversion to the Mean during Unforeseen Circumstances

An International Analysis of the Bollinger Bands Investment Theory during the Corona Virus

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Topic Summary

The main research question of this thesis is as follows:

> **"How effective is the Bollinger Bands investment theory in creating profits while investing in stocks, and what effect has the Corona Virus had on it?"**

The answering of this question benefits academics, and the research results are applicable to investors of stocks and other traded commodities. Additionally, this thesis seeks to provide insights into the effects that the Corona Virus has had upon stock valuations and the BBS investment theory. Doing so provides a firsthand look into this unique situation which has not yet been extensively studied. Moreover, the combination of these two subjects provides valuable novel insights into this currently unexplored topic. In order to add international applicability to the thesis, all stocks from Germany's Deutscher Aktienindex (DAX) index, all stocks from the United States' Dow Jones Industrial Average (DJIA) and the top 30 stocks from the Standard and Poor's 500 (S&P) indices, and the top 30 stocks from the United Kingdom's Financial Times Stock Exchange (FTSE) index are analyzed within this thesis. To answer the main research question the following sub questions are studied:

1. **Internationally, how has the traditional Bollinger Band investment theory performed in recent years?**

To answer this, all 120 stocks from the aforementioned indices are analyzed. Daily returns from the past four years are studied, and breaks outside of the higher or lower BBs are noted. The direction that the stocks take following a BBs break are then noted and analyzed. The second sub question is as follows:

2. **To what extent has the Corona Virus affected stock markets in Germany, the US, and the UK?**

The initial step in answering this sub question is analyzing the performance of the overall indices within 2020, and comparing the results with the four previous years. Thereafter, the stocks within the indices are further analyzed to give a more detailed answer. By doing so, trends within the stock markets are also identified. This includes determining which stocks most heavily contribute to the markets' downturns, and also determining if any stocks have experienced growth phases during the CV, thereby lessening the impact on the overall market. Finally, the third sub question bridges these two topics and serves as an application for the gathered results:

3. **How has the profitability of the Bollinger Band investment theory been affected by the Corona Virus?**

This sub question is answered from the culmination of knowledge gathered from the previous two sub questions. Naturally, this sub question is also answered internationally from the three countries listed above. Insights gathered from this sub question provides novel insights into this currently unexplored combination of topics.

Summary of Results

Sub Question 1
For the sake of concision, only the results of the DJIA are presented in this summary.

Figure 1 Returns of the Bollinger Bands Investment Theory on Dow Jones Industrial Average Index Constituent Stocks from 01.01.2016 – 31.01.2020

DJIA	First Day	Last Day	Growth	Trades	Days Out	Return
AAPL	$ 26.34	$ 77.38	193.77%	35	683	(45.15%)
AMGN	$ 158.34	$ 216.05	36.45%	43	649	36.76%
AXP	$ 67.59	$ 129.87	92.14%	39	590	31.37%
BA	$ 140.50	$ 318.27	126.53%	30	520	(5.31%)
CAT	$ 67.99	$ 131.35	93.19%	38	525	64.33%
CRM	$ 76.71	$ 182.31	137.66%	38	538	92.59%
CSCO	$ 26.41	$ 45.97	74.06%	38	553	39.91%
CVX	$ 88.85	$ 107.14	20.59%	38	523	48.74%
DIS	$ 102.98	$ 138.31	34.31%	36	520	20.18%
DOW	$ 49.80	$ 95.87	92.51%	8	102	17.63%
GS	$ 177.14	$ 237.75	34.22%	40	482	67.54%
HD	$ 131.07	$ 228.10	74.03%	37	551	20.60%
HON	$ 97.65	$ 173.22	77.40%	36	526	30.92%
IBM	$ 135.95	$ 143.73	5.72%	37	566	27.96%
INTC	$ 33.99	$ 63.93	88.08%	40	524	38.80%
JNJ	$ 100.48	$ 148.87	48.16%	36	516	30.54%
JPM	$ 63.62	$ 132.36	108.05%	42	566	50.22%
KO	$ 42.40	$ 58.40	37.74%	42	494	61.69%
MCD	$ 117.58	$ 213.97	81.98%	33	491	21.20%
MMM	$ 146.82	$ 158.66	8.06%	35	507	34.94%
MRK	$ 52.48	$ 85.44	62.80%	39	553	65.65%
MSFT	$ 54.80	$ 170.23	210.64%	36	446	72.26%
NKE	$ 61.52	$ 96.30	56.53%	40	568	75.08%
PG	$ 78.37	$ 124.62	59.01%	42	558	53.11%
TRV	$ 109.97	$ 131.62	19.69%	37	440	36.55%
UNH	$ 116.46	$ 272.45	133.94%	43	611	74.20%
V	$ 75.70	$ 198.97	162.84%	34	513	39.84%
VZ	$ 45.87	$ 59.44	29.58%	40	589	42.00%
WBA	$ 83.05	$ 50.85	-38.77%	41	497	95.83%
WMT	$ 61.46	$ 114.49	86.28%	39	523	31.04%

The table is situated with the numbers used to calculate the natural growth of the period being placed on the left side of the chart. The numbers pertaining to the BBs investment theory are placed on the right side of the chart and are highlighted blue. Presented in the chart from the left most column are the stocks' ticker symbols, followed by their prices at the beginning of the period, their prices at the end of the period, and the growth that these starting and ending points equates to. Following this, heading the blue BBs section is the trades column, which signifies the number of times that the investment theory signaled that a position should be made. Following this in the "Days Out" column are the number of days outstanding that the investment theory signaled the positions should be held for e.g. one trade should be held for 5 days, plus one trade should be held for 21 days, et cetera. In effect, this column portrays the number of days that an investor's capital would be employed. The last column on the far right displays the value that would be obtained with the BBs investment theory. It should also be noted that the stock of Dow Inc. (ticker symbol DOW) was created due to a merger near the beginning of April 2019. This means that it did not have data available for the entire period, making some of its variables incomparable, which is why it is highlighted in the table.

While looking at the right side of the table pertaining to the BBs investment theory, the average return gathered from all stocks with data available for the entire period is equal to 43.22%. Furthermore, the standard deviation of the applicable stocks is equal to 28.04%, which illustrates the wide range of returns that the BBs investment theory produced.

Two of the stocks however lost value when traded using the BBs investment theory – Apple (AAPL) and Boeing (BA). Solely trading BA stock would have lost an investor -5.31%, whereas AAPL would have lost -45.15%. As AAPL stock was the only stock which resulted in a moderate loss when employing the investment theory, it was analyzed in further detail in the full thesis. The results of the analysis was the following: there were four particular trades that accounted for a total loss of -76.84%. Naturally, without these four trades an investor would have made a moderate income while trading the stock. Each of these trades had the same circumstances surrounding them, namely, that a position was opened directly before the stock suddenly changed momentum and either grew or lost value at a rate that was uncharacteristic of its previous movements. Naturally this happened throughout the studied timeframe, meaning that this did not cause the theory to fail outright, but rather that when this does happen, losses may occur if there happens to be an open position, and if the stock moves in a direction opposing this position, i.e. a 50% chance given the rare previous circumstances are also met. This is a very unlikely scenario which is illustrated by the predominantly positive results seen in the table above, but it should be noted nonetheless. The majority of all stocks in the other indices also acquired moderate to substantial gains when traded with the investment theory.

Sub Question 2

Figure 2 Index Growth Rates 01/01/2016 – 31/01/2021

Index	H1 2016	H2 2016	H1 2017	H2 2017	H1 2018	H2 2018	H1 2019	H2 2019	H1 2020	H2 2020	Jan 2021
DJIA	4.55%	10.10%	7.38%	15.08%	-2.23%	-4.03%	13.94%	6.82%	-10.59%	18.93%	-0.80%
S&P	4.28%	6.46%	7.33%	10.07%	0.84%	-8.06%	17.20%	8.99%	-4.84%	20.55%	0.37%
DAX	-5.87%	17.44%	6.27%	3.55%	-4.39%	-6.26%	17.19%	5.81%	-8.03%	11.89%	-2.14%
FTSE	6.74%	8.59%	1.88%	4.21%	-0.15%	-10.86%	10.27%	0.60%	-18.87%	4.91%	-2.50%

The table above displays the growth that each index experienced in the half of the year signified in the top row, e.g. H2 2017 is the second half of 2017. The growth rate is color coded to ease in comparison, with green signifying increases in value and red signifying loss of value. Naturally, the shade of green or red signifies the amount that was gained or lost. The three right most columns contain data surrounding the corona virus pandemic, and are highlighted yellow to ease recognition and aid with comparison. The last most column contains data only from January, 2021, as opposed to the other columns which contain data for full 6 months. As such, the growth amounts are not comparable, but were still added to allow for additional insight into the markets.

While each index's constituent stocks were analyzed in the thesis, only the index averages are detailed within this summary. This is done for the sake of concision, and as the index averages are indicative of their constituent stock's growth patterns. From this data it can be seen that the markets grew in the majority of the years, apart from the 2018 stock crash, and the beginning of the Corona Virus Pandemic in the first half of 2020. It should be noted that the second half of 2020 was characterized by growth phases which outgrew the losses incurred in the first half of the year in the American and German indices. The UK index, however, was negatively affected the most by the CV pandemic, and was not able to adequately recover in the second half of the year. This year was primarily characterized by high levels of volatility within all of the indices.

Sub Question 3

Figure 4.18 Comparison of Pre and Post Corona Virus DJIA Stock Bollinger Band Returns

DJIA	Return	R/T	R/D	R/T	D/T
Stock	Post Corona Virus			Pre Corona Virus	
AAPL	-11.15%	-1.59%	22.29	-1.29%	19.51
AMGN	1.86%	0.23%	13.63	0.85%	15.09
AXP	32.05%	4.01%	12.00	0.80%	15.13
BA	-43.43%	-6.20%	17.71	-0.18%	17.33
CAT	19.15%	2.13%	12.00	1.69%	13.82
CRM	44.34%	4.43%	10.30	2.44%	14.16
CSCO	-1.69%	-0.28%	18.83	1.05%	14.55
CVX	2.40%	0.30%	12.38	1.28%	13.76
DIS	-15.31%	-2.19%	18.57	0.56%	14.44
DOW	2.93%	0.37%	12.88	2.20%	12.75
GS	-4.85%	-0.54%	12.89	1.69%	12.05
HD	21.34%	2.67%	9.00	0.56%	14.89
HON	13.54%	1.50%	13.67	0.86%	14.61
IBM	30.28%	3.03%	11.60	0.76%	15.30
INTC	60.79%	6.75%	11.78	0.97%	13.10
JNJ	17.35%	2.48%	12.57	0.85%	14.33
JPM	5.85%	0.73%	12.25	1.20%	13.48
KO	33.83%	3.76%	9.89	1.47%	11.76
MCD	5.78%	0.58%	13.30	0.64%	14.88
MMM	14.72%	2.10%	11.71	1.00%	14.49
MRK	21.27%	2.66%	13.25	1.68%	14.18
MSFT	23.50%	2.94%	11.50	2.01%	12.39
NKE	-1.34%	-0.19%	15.29	1.88%	14.20
PG	25.71%	2.86%	10.22	1.26%	13.29
TRV	-8.32%	-1.19%	15.14	0.99%	11.89
UNH	73.92%	6.72%	10.27	1.73%	14.21
V	11.32%	1.62%	14.29	1.17%	15.09
VZ	16.86%	1.87%	15.67	1.05%	14.73
WBA	83.02%	8.30%	8.90	2.34%	12.12
WMT	50.14%	3.86%	7.31	0.80%	13.41

In the graph above, the returns gathered from using the investment theory during the Corona Virus are placed on the left. The returns from using the investment theory in recent years before the CV, which was discussed in sub question 1, are displayed in the 2 columns which are highlighted on the right side. The measurements of R/T and D/T stand for Return per Trade, and Days Outstanding per Trade. These measurements were added to allow for comparability between the pre and post CV returns. This is necessary as the pre CV returns were gathered over 4 years, whereas the CV returns were gathered over only 1 year, thereby skewing the data. That being said, these new measurements allow for comparison between these datasets. Moreover, these variables allow for comparison even with stocks that did not have data available for the entire studied timeframe. The overall returns gathered during the CV are also added to give further insight into the CV results.

When looking into the DJIA's constituent stocks, great variation can been seen when trading with the BBs investment theory during the corona virus. The average return was 17.53%, ranging from an

income of 83.02% which was experienced by Walgreens Boots Alliance (WBA), to a loss of -43.43% which was experienced when trading Boeing (BA). BA stock was distinguished in the last sub question as it lost the most value out of any DJIA stock in the first half of 2020 when the CV struck. Interestingly, WBA stock was also characterized as being one of the stocks which lost the most value in the first half of the year. This points to the conclusion that loss in stock value does not equate to loss of value when trading with the BBs investment theory given that these two stocks attained opposing investment returns.

In total 18 of the 30 DJIA stocks experienced a higher R/T during the CV. This mark lies near the 50% mark as does that of the other indices. 14 of the top 30 stocks in the S&P, 13 of the 30 DAX stocks, and 15 of the top 30 stocks in the FTSE experienced higher returns during the CV pandemic. This leads to the conclusion that increased volatility does not cause the investment theory to perform better or worse on average.

Conclusions

From the first sub question it was seen that the Bollinger Bands investment theory performed well in recent years. In the grand majority of cases, employing the investment theory would have brought an investor moderate to large gains. This was seen throughout the Dow Jones Industrial Average and Standard and Poor's indices in America, the Deutscher Aktienindex in Germany, and the Financial Times Stock Exchange in the United Kingdom. Furthermore, it was seen that the theory performed well both when trading stocks that were gaining or losing value overall. That being said, there were rare occurrences of stocks which resulted in overall losses when traded with the theory.

When looked into further, these stocks which lost value while using the theory did not do so because the stock itself was losing value. Rather, losses occurred only in specific circumstances when the underlying stock changed momentum. Furthermore, value was not lost during every momentum shift. Rather, value was only lost if there was a preexisting position open when a momentum shift occurred, if the shift caused the stock to move in a direction opposing the original trade. In effect, this is a 50% chance of losses given that a position was opened directly before the stock shifted momentum. This makes losses a rare occurrence, although when they did occur sometimes large losses were realized. However, using stop limit orders negates the possibility of large losses and ensures that the investment theory remains very profitable overall. With that in consideration, it can be concluded that the investment theory performs well both when the underlying stock has positive or negative momentum, but that rare losses may occur during a momentum shift.

The second sub question assessed the impact that the Corona Virus had upon the studied indices in the USA, Germany, and UK. During 2020 stocks most commonly experienced moderate to severe recessionary phases in the first half of the year, while the second half of the year was characterized by moderate to large growth phases. The growth in the second half of the year often times outgrew the losses, leading the majority of stocks to finish the year in a better position than the beginning. This was true with the American and German stocks, although it was seen that in the UK stocks incurred a larger negative impact in the first half of the year, and only slight growth was achieved in the second half of the year. Although there were differences between stocks of the different indices, it can be said that high volatility was seen across the board in this year.

The affect that this volatility had upon the profitability of the investment theory however, was not straightforward. In the third sub question the return per trade in recent years and during the CV were noted. When comparing this variable, it can be seen that returns gathered using the investment theory during the CV were not primarily higher or lower than the returns seen in the preceding years. In fact,

the proportion that was higher was very close to the 50% mark in all cases. For reference, within the DJIA index 18 of the 30 stocks had better returns, in comparison to the S&P with 14, the DAX with 13, and the FTSE with 15. This equates of subsequent percentages of 60.00%, 46.67%, 43.33%, and 50.00% of the stocks performed better during the CV. Because of the closeness of these percentages to the 50% mark, it can be concluded from the data that volatility has no positive or negative impact on profitability of the investment theory.

That being said, larger spreads of returns can be seen during this volatile timeframe. In the years preceding the CV, the return per trade of the DJIA stocks ranged from a low of -1.29% to a high of 2.44%. During the CV, however, the DJIA return per trade ranged from -6.20% to a high of 8.30%. Furthermore, the standard deviation of this metric during the CV is 2.83% in comparison to the standard deviation of 0.74% which was seen in the previous years.

The same can be said for the other indices. Returns per trade from the S&P stocks ranged from -1.29% to 2.48% before the CV, in comparison to values of -3.23% to 6.72% during the CV. This equates to a standard deviations of 0.81% in the years before the CV, and 2.29% during the CV timeframe. R/T from the DAX stocks ranged from -1.83% to 2.83% before, and from -4.05% to 4.54% during the CV. This equates to standard deviations of 0.89% before and 2.36% during. R/T of FTSE stocks ranged from -0.87% to 3.20% before, and from -10.50 to 6.64% during the CV. The standard deviations of these returns are 0.75% before and 3.39% during the CV.

With that in consideration it can be concluded that while volatility does not increase or decrease the returns gathered while employing the BBs investment theory, it does, still affect the profitability. Specifically, when the volatility of the underlying stock rises, volatility in the returns gathered from the investment theory also rises. Therefore it is up to an investor to decide whether higher risk is appropriate for their investment preferences, given that volatility does not uniformly impact the BBs investment theory in a positive or negative way.

The main research question reads: "How effective is the Bollinger Bands investment theory in creating profits while investing in stocks, and what effect has the Corona Virus had on it?" Through the analyzed data it is concluded that the Bollinger Bands investment theory is efficient in creating profits. The effect that the Corona Virus had upon it was that as volatility increased within the national markets, volatility of returns were also realized. That being said, the Corona Virus did not positively or negatively affect the investment theory as a whole. For that reason it is concluded that the investment theory performs very well overall, even during unforeseen circumstances.