



12-15-2003

Are Stock Prices Related to New York's Climatic Conditions?

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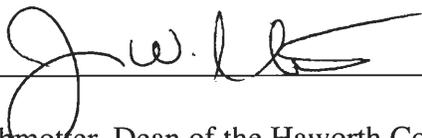
"Are stock prices related to New York's climatic conditions?"



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11/23/03

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Abstract

The past five years has shown tremendous growth in a new wave and style of investing strategy. This new style, known as behavioral investing, attempts to analyze financial markets through the eye of a social scientist rather than a financial professional. Its followers try to see market movements as affected not necessarily by the business or economy but by the cognition and mood of buyers and seller. This paper analyzes the effect of climatic conditions on mood and the effect that has on market movements and volume. For the most part, it was found that there is no significant relationship between most climatic conditions and market returns on the New York Stock Exchange. However, the study does open doors and encourages ideas for further research in this area.

Introduction

From the first day in any introductory investments class, students are told that there are two primary motivations in security markets, especially the stock market. These motivations are fear and greed. Such has been the case in investment education for a very lengthy period of time. At the same time, professors also teach a more widely accepted, though differing point of view known as the efficient markets hypothesis. This paper briefly examines the difference between behavioral investments and the efficient market theory before discussing ideas behind behavioral finance in depth. Finally, some research has been done in analyzing behavioral possibilities regarding the climate in New

York and the relationship that climate might have with stock prices for stocks traded in New York.

The History and Origins of Behavioral Finance

In 1969, University of Chicago finance professor Eugene Fama proposed a revolutionary idea stating that all markets are efficient (Fox, 2002). Market efficiency in this case has a double meaning. The first is that it can mean that investors cannot systematically beat the market. The second is that security prices are rational (Statman, 1999). According to Fama there is only one way to beat the market return given a certain amount of risk. Insider trading, a hot topic today, is the one and only way Fama could see for gaining excessive market returns at a given level of risk. For many years up to and including present day, people took his research very seriously and through time, it has come to be a cornerstone in investment education.

Today, market efficiency has even been divided into three subgroups: weak-form market efficiency, semi-strong form market efficiency and strong form market efficiency. Weak form market efficiency states that stock prices reflect all historical information. Semi-strong form market efficiency builds on weak form by stating that prices also reflect all public information and react almost instantaneously to new information. Finally, strong form market efficiency states that prices reflect all historical data, all public data and all private information with new information being assimilated into prices almost instantaneously (Hearth and Zaima, 2004). But even with all of this structure and theory, a new approach has come to be.

Though it has taken time to catch on, the term behavioral finance is the newest buzzword in investment analysis, and more than that it is starting to gain a serious hold in

some investment arenas. The concept, though introduced much earlier, first gained a great deal of popularity in the mid to late nineteen nineties. The dot com bubble, also known by Alan Greenspan's title "irrational exuberance" brought the fact that markets are not always rational directly into the spotlight. Corporations had price to earnings ratios in the thousands to one. Stock prices soared while Internet companies continually posted losses. Yet the funds kept rolling in for them from irrational investors. In simple, introductory investment terms, the market was driven by greed. Too many people thought they could not lose and too many people blindly put their money into technology companies without any real working knowledge of their chosen company or even that industry. Simply put, irrational behaviors caused people to break almost every rule outlined in any basic investment course.

Similar to any bubble, the bull market caused by technology in the mid nineteen nineties had to pop. In late nineteen ninety-nine and early in the year two thousand, the federal reserve board increased interest rates and Alan Greenspan gave his infamous speech on irrational exuberance. Since then, behavioral finance has been taken much more seriously. The technology bubble was a perfect example of how markets are not always rational (Mankiw, 2000). Somewhere in this bubble it became apparent that psychology, sociology and the social sciences in general did have some part in the development of prices in the security markets. Thus the realism of behavioral finance was born.

Robert Shiller became one of the originators of the movement of behavioral finance by publicly refuting Eugene Fama's arguments for efficient markets (Lowenstein, 2000). Today others have stepped up into the spotlight as strong advocates of the theory.

Richard Thaler is by far the most widely known advocate of behavioral finance. In addition, in 2002, behavioral finance was solidified as a very real theory when the Nobel Prize committee awarded half of that year's prize for economics to Daniel Kahneman of Princeton University. Kahneman was recognized "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty." (www.nobel.se)

Applications of Behavioral Finance

There are many promises that behavioral finance can offer to investors looking to maximize returns while minimizing risk. Clearly, one of the great promises behavioral finance holds comes in its ability to explain movements that conventional theory was unable to explain before. Behavioral finance explains many reactions on financial markets that appear to be contrary to conventional theory. This understanding can allow investors to avoid making serious mistakes twice or more and has potential in allowing investors to develop a strategy that profits from the conventional theories employed by other professionals. While behavioral finance is not particularly well suited for picking individual winners or losers in the market, it is able to open doors to large areas or industries where mistakes may be made similar to the technology bubble in the late twentieth century.

Richard Thaler has done a great deal of work showing that behavioral finance is more than just hot air. Thaler created three stock mutual funds to test the efficient market theory. Those funds are: The Behavioral Value Fund, The Behavioral Growth Fund and The Behavioral Long/Short Fund. All three funds seek to use behavioral finance to profit from the foibles and mistakes of other investors and all three have consistently

outperformed the market (Epstein, 1999). Another fund Thaler manages is the Undiscovered Managers Behavioral Growth Fund. This fund has also outperformed the market. In 1998 and 1999, this fund returned a cumulative 120.7% while the Standard and Poor 500 index has returned a cumulative 55.6% (Clements, 2000). Finally, Thaler also put together a number of funds in his asset management business, Fuller and Thaler Asset Management. Their Small/Mid Cap Growth Fund returned 13.2 percent in 1999, while the small cap value fund returned 27.5% in the same period, all based on behavioral investing strategies (Carnahan, 2000).

Another example of the usefulness of behavioral finance came in a study done by Daniel Kent and Sheridan Titman. Their project began with a discussion of the general acceptance of the efficient markets hypothesis in financial management today but went on to mention that investor overconfidence can produce momentum in stock returns. This momentum is likely to be strongest in stocks whose valuations required the interpretation of ambiguous information. Moreover, the momentum effects were found to be stronger for growth stocks than for stable stocks. They put together a test portfolio strategy based on this theory and received strong abnormal returns from U.S. equity portfolios that did not seem to be attributed to increased risk.

How Behavioral Investing Works

Behavioral finance and investing treats people as dynamic, moving creatures whom alter prices through experiencing stimuli with all of their senses and perceptions, including everything from the emotions fear and greed to unknown biological changes that alter unconscious mood. People are ever-changing and behave based on everything they experience and perceive. It could be argued that there is not a single human that

works or invests solely on what is rational to a perfect cognition. Until we have computers that are unfeeling and unperceptive, yet able to make decisions independently, a person's psychology and social environment will always have some effect on that person's investments (Shiller, 2003)

With this in mind, behavioral investors go beyond what is rational. Our world is not black and white and assumptions used to simplify academic theories do not necessarily hold true. Behavioral finance looks to understand everything with no assumptions aside from the idea that behavior, motivation and mood can produce similar results repeatedly. All that is understood to be constant is that patterns in behavior and responding do still exist.

Theorists and professionals can gain from this information if they are able to look at patterns produced by human behavior. Their approach is very eclectic, containing views gained from psychological and sociological research and understandings (Shiller, 2003). The behavioral analyst will buy and sell based not necessarily on the economy, industries or companies. Rather they will buy or sell based on the anticipated perception of the economy, industries and companies by the investing population at large. Perception is what makes behavioral investing possible. In the mid nineteen nineties, people perceived that technology stocks had nowhere to go but up. They saw that other investors were dumping enormous amounts of money into these stocks and so they did the same without thinking about the rationality of their situation, which a rational person wouldn't have thought hard to consider with price to earnings ratios in the thousands. Some practitioners and academics even go to behavioral finance to understand stock

market difficulties and come back reasoning that we don't go through bear markets, only corrections in irrational, inefficient practices (Burr, 1998)

Complications/Criticisms of Behavioral Finance

Not everyone is falling in love with the idea of behavioral finance proposed by Thaler, Kahneman and Shiller. Dick Michaud, a well-known analyst, not only disapproves of the idea, but he puts forth energy to publicly insult those who use it. In a recent article by Hal Lux in *Institutional Investor* it became clear that Michaud is out to ridicule behavioralists claims that quirks in the market can be attributed to irrational psychology. Through extensive use of financial research and his own hyperbole, Michaud often attempts to smash the idea that financial behaviors are motivated by the irrational. In addition, he declares that such assertions are most often accompanied by a lack of academic rigor (Lux, 2002). It seems that his arguments against Behavioral Finance, however, are limited aside from his eagerness to ostracize those investigating it.

Some concerns held by a large majority of people come in the usefulness of behavioral analyses. One such concern comes in the dichotomy between academia and practice. Some people are concerned that while behavioral investing makes sense in the academic world (enough to earn it a Nobel prize), it may not necessarily transfer into a moneymaking investment idea (Holland, 2002). Ken Fisher of Fisher investments is one of the people concerned with its applications in the real world. Fisher contends that while behavioral analyses may be an interesting academic topic, they are "thin on the ground" and more hype than reality (Chernoff, 2000).

Mood, Climatic Conditions and Stock Returns

Most of the behavioral analyses being done in investing are done with a focus on human cognition. That is, they are focused on the mental processes and patterns involved in investing. However, some of the most recent behavioral analyses in understanding financial markets have come in understanding the human psychology from a biochemical standpoint. Some academics are starting to concern themselves less with thought processes common to all humans and more with the chemistry that might influence those thought processes.

One of the new areas and the primary investigation of our discussions comes in mood alterations caused by physiologically induced chemical changes in the body and brain caused by environmental stimuli. More simply, time was spent looking at atmospheric conditions and the effect those conditions have on chemicals in the body and therefore mood.

Scholars, for the most part, have been in debate over whether atmospheric conditions are a cause for changes in mood. It seems that for every study suggesting that external climate be a factor in mood, there is another study suggesting otherwise.

One of the primary indicators that mood is affected by external climates comes in the existence of a mental disorder termed seasonal affective disorder. Season affective disorder is a “mood disorder involving at least two episodes of depression in the past two years occurring at the same time of the year (most commonly fall or winter), with remission also occurring at the same time of the year (most commonly spring) (Carson, Butcher, Mineka. 2000). This disorder is also recognized as a very real disorder by the American Psychiatric Association. This association publishes the definitive book on

disorders of the mind: *The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*. In the DSM IV, the seasonal affective disorder is listed as a seasonal pattern specifier to bipolar I and II disorders or major depressive disorder, recurrent.

The fact that the American Psychiatric Association in their definitive manual of mental disorders does find a person's external environment to be one of the determining factors of mood is very noteworthy in our current study. Hundreds of doctors have contributed to the DSM IV and just over a hundred doctors contributed to the section on mood disorders alone. This suggests a vast panoply of professional knowledge that has come to support the idea that a person's external environment does affect their mood and therefore their cognition.

Furthermore, a study was recently done entitled "Effect of sunlight and season on serotonin turnover in the brain." This study looked at 101 healthy men ranging in age from years 18-79. The study called for consistent sampling and analysis of their blood from the internal jugular vein (coming directly from the brain) to record levels of serotonin output in various seasons. (Serotonin is a major neurotransmitter associated with happiness in mood.) The study concluded that there was a difference in serotonin output by the brain in different seasons. Turnover of serotonin in the brain was highest in summer and lowest in winter. Increased luminosity also caused an increase in serotonin output by the brain (Lambert, Reid, Kaye, Jennings, Esler 2002).

Even more interesting are a few studies that have already gone to link climate affected moods with stock market performance. One such study looked directly at Seasonal Affective Disorder (SAD) as an indicator of stock market movements. The study was conducted to determine the effect of SAD on stock market returns around the

world. The study called for a close look at stock markets located at various latitudes on both sides of the equator and differences in seasonal variation of daylight across countries. Their findings strongly supported a SAD effect in the seasonal cycle of stock returns that is both significant and substantial, even after controlling for well-known market seasonals and other environmental variables. Another important note is that the researchers found that higher-latitude markets show more pronounced SAD effects and results in the Southern Hemisphere are six months out of phase, as are the seasons (Kamstra, Kramer, Levi, 2003).

Finally, a study was published in June 2003 that looked directly at stock returns and the weather in markets throughout the globe. This paper was entitled “Good Day Sunshine: Stock Returns and the Weather.” The researchers looked at daily market index returns and sunlight across twenty-six countries from 1982 to 1997. After the analysis was completed and all confounding and controllable extraneous variables were taken into account, the researchers found that there was strong, positive correlation between sunlight and stock index returns. Furthermore, the researchers looked at the possibility of gaining from weather information while investing. They found that weather based trading strategies were a little more than hot air, but with anything more than low transaction costs, abnormal gains would be eliminated. Nevertheless, the researchers determined that these findings are “difficult to reconcile with fully rational price setting.” (Hirshleifer, Shumway. 2003.)

While there is a great deal of evidence that seasonal variations affect mood and thus market performance, there are also studies that suggest that seasonal variations do not affect mood. One such study was entitled “No Changes in Mood with the Seasons:

Observations in 3000 chronic pain patients.” This study investigated the distribution of depressive moods during the year in a region at 50 degrees North Latitude, where considerable changes in climate occur with the seasons. The study called for hospitalized chronic pain patients to fill out a depression questionnaire routinely as part of the diagnostic interviews at a pain clinic in Mainz, Germany over a five-year period. The analysis was performed separately for men and women and showed that there was no significant effect on mood in various months or years, even in women whom SAD is shown to be present most often. The authors concluded that the effect of light or seasonality on depression may be smaller than expected (Hardt, Gerbershagen. 1999).

There is one other study that claims climate does not influence moods entitled “The Influence of Weather on Moods: An Idiographic and Nomothetic Approach.” This study was designed to improve past methodologies. It looked at four widely believed hypotheses. The first was that anger is correlated with heat. The second was that tiredness is correlated with heat. The third was that sadness is correlated with cloudy skies. And the fourth was that happiness is correlated with clear skies. A secondary hypothesis was that personality variables moderate mood-weather relationships. Each mood was assessed with a corresponding scale. Heat was operationalized as temperature, dew point, relative humidity and wind chill. Sky conditions were operationalized as solar radiation, cloud base altitude, cloud cover and horizontal visibility. Participants rated their moods 3 days a week for one semester. Statistics were then calculated and little support was found for hypotheses at the group level. However, at the individual level, results varied widely suggesting that there are robust individual differences in mood-weather relationships (Hoeglund, 2002).

“Are Stock Prices Related to New York’s Climatic Conditions?” Purpose

The purpose of my own study is to expand upon and to some degree replicate studies that have been done in the past, most notably the Hirshleifer/Shumway study entitled “Good Day Sunshine: Stock Returns and the Weather.” As with most good research, a great deal of replication is done before ideas become widely accepted. The analysis presented in this paper does, for the most part, replicate the methodology presented by Hirshleifer, however, I have taken a smaller sample and looked at many things other than cloud cover and stock returns, including volume, snow depth, total precipitation, daily mean temperature, delta mean temperature, mean dew point and mean sea level pressure.

My goal in this study, as stated earlier, is to see for myself whether stock market prices are affected by the weather conditions in New York. If this is true, it may hold some possibilities for behavioral investing and perhaps even abnormal gains if markets truly are less efficient than Eugene Fama believes.

Data:

For this project, it was necessary to collect data on a daily basis for weather conditions in New York as well as daily New York Stock Exchange volume data and closing Dow Jones index prices. This information was obtained from a number of websites. Climatic and meteorological data came from two primary sources: The National Oceanic and Atmospheric Administration (NOAA) and The Farmer’s Almanac online.¹ The Farmer’s Almanac published historical weather information for New York city that was gained directly from the weather station at LaGuardia national airport. Likewise, NOAA had information coming directly from its weather station at LaGuardia

¹The addresses for these web pages are www.NOAA.org and www.almanac.com, respectively.

national airport. Historical stock index and volume prices were a little easier to obtain. Most websites with any financial information contain historical stock index and volume information. The website most useful and least complex was the financial section of the yahoo web page.²

After obtaining the data, it was organized into an excel spreadsheet. Each day of the business week was put in a row with the index prices, volume and weather patterns for that day. Data was not collected for weekends and holidays simply because stocks are not traded on weekends or holidays. Therefore the volume equals zero and the closing price does not change.

Methodology:

The primary focus of this study is simply to test stock index movements against weather occurrences for patterns. To test this, daily weather, index and volume data collected for almost ten years was used. The primary methods of testing for relationships included running statistical correlations and regressions. Correlations and regressions were run between daily volume and snow depth, total precipitation, delta daily mean temperature (calculated by subtracting the previous day's temperature from the day's temperature), daily mean temperature, daily mean dew point and daily mean sea level pressure. Correlations were also run between each of these climatic conditions and daily return. Daily return was calculated by figuring the percentage change in index price between a day and the day before it. For each statistical correlation run, a regression was also run to test for how one variable affects another. In each case, the x points were climatic conditions and the y variables were either volume or the daily index returns.

² The address for this web page is www.finance.yahoo.com.

The only data eliminated from the study was weather, index and volume data in the week following the September eleventh tragedy at the World Trade Center towers. It can be easily understood that changes in volume and index price during this week cannot be attributed to the weather. Obvious, radical changes occurred simply because of the concerns investors had following the attacks. Other seasonal variations such as the December effect³ have not been controlled for in this study because the absolute cause of the effect is unknown. It may have been possible, however unlikely, that the December effect is caused by the change of seasons as heavy snow usually falls for the first time of the season during mid-December.

Results:

The correlational analyses produced no surprising results. The correlations are summarized in the following table.

Correlations	Volume	Daily Return
Snow Depth	-0.07083	-0.02116
Precipitation	0.09211	-0.00899
Delta Daily Mean Temp	0.00271	0.02184
Mean Temp	0.01125	-0.01964
Mean Dew Point	0.01736	-0.02031
Mean Sea Level Pressure	-0.01018	-0.00717

As it is shown in the above table, there are no significant correlations between any of the climatic variables and volume or daily return. A perfect positive correlation is one in which one variable moves one way a certain percentage of points and the other variable moves the same way a certain percentage of points. A perfect negative correlation is the same except the variables move in opposite directions. For example, there may be a strong positive correlation between lawnmower sales and temperature. As

³ The December effect is an anomaly in market valuation in which stock prices consistently and predictably go down during the month of December and back up in January. The cause of this is widely debated.

one goes up, so does the other. Likewise, there may be a strong negative correlation between snow blowers and temperature. As one goes up, the other goes down. A perfect positive correlation has a correlation coefficient of one. A perfect negative correlation has a correlation coefficient of negative one. A correlation coefficient of zero indicates that there is no relationship at all. As the table above indicates, none of the factors analyzed in this study are anywhere near a strong positive or negative correlation.

Regression, performed by Microsoft Excel, shows a little more. Specifically, it shows how one variable reacts to another. In our study, regression analysis will show how index returns and stock exchange volume are affected by weather. In each case, the y variable is the financial information and the x variable is the climatic information. The table below summarizes given formulas regarding weather effects on returns and p-values to indicate significance.

	Daily Return		
	Given Formula	P-Value	Conclusion
Snow Depth	$y = .000530112 - .000135087x$	0.2963	Not Significant
Total Precipitation	$y = .000508606 - .00000488518x$	0.6573	Not Significant
Delta Mean Temperature	$y = .000486105 + .000036961x$	0.2811	Not Significant
Mean Temperature	$y = .001206424 - .0000128994x$	0.3326	Not Significant
Mean Dew Point	$y = .00120342 - .0000125215x$	0.3162	Not Significant
Mean Sea Level Pressure	$y = .000921597 - .0000004265x$	0.7234	Not Significant

This statistical analysis supports the efficient markets hypothesis by showing that returns are not related to weather patterns. Each formula is tied to a p-value that is not significant; that is, the p-value is greater than .05%. This means that we should not have confidence in the formula given by the regression.

Volumes did, however, have some significance. The relationships between climatic conditions and New York Stock Exchange volume is more expected, but was

still worth looking into. The results for this analysis are summarized in the following table.

	Daily Volume		
	Given Formula	P-Value	
Snow Depth	$y = 7961419.089 - 176388.6801x$	0.00046667	Significant
Total Precipitation	$y = 7816766.961 + 19529.08432x$	0.00000525	Significant
Delta Mean Temperature	$y = 7904612.273 + 1786.8776x$	0.8938	Not Significant
Mean Temperature	$y = 7743697 + 2884.1746x$	0.5787	Not Significant
Mean Dew Point	$y = 7726642.286 + 4175.9325x$	0.3916	Not Significant
Mean Sea Level Pressure	$y = 8415374.647 - 236.02937x$	0.6516	Not Significant

This table indicates that snow depth and total daily precipitation do have a significant effect on the volume of stocks in a given day. For some people, this may have been intuitive, but the numbers solidify the fact that snow and precipitation affect volume. On the other side, temperature, change in temperature, dew point and sea level pressure have no significant effect on daily trading volume.

These results, for the most part, do not support a case for behavioral investing based on mood alterations caused by weather. This does not mean that behavioral investing is all nonsense. It simply means that there is no solid application for behavioral investing based on weather patterns beyond sunlight. Cloud cover, however, may still be seen as a pattern affecting mood enough to change stock returns as shown by the study entitled “Good Day Sunshine: Stock Returns and the Weather.” The only way to solidify these findings is to replicate these studies in different ways and to different extremes with possibly different levels of control.

Suggestions for Further Research

As mentioned already, there is more to be done than this single study before climatic conditions can be positively known to be ineffective (or effective) in altering financial returns. Some ways in which researchers can expand upon this study and

“Good Day Sunshine...” might be to take a look at data covering a greater range of years. This study for example, only went back approximately ten years. Another idea would be to look at cross-cultural differences in the effects of weather. Different cultures often perceive things differently, even when they seem as hardwired as biochemistry. For example, the effects of the drug marijuana on a person’s biology and behavior may seem hardwired, but while American users report laziness and content with doing nothing while on the drug, Chinese users report an increased desire for work. Perhaps changes in the weather can produce the same effect. A cross-cultural study on this possibility may be worth looking into. Finally, it may be worth looking at markets located at extreme latitudes where sunlight changes drastically from summer to winter. Analyzing other variables such as snowfall, precipitation, temperature, et cetera in these latitudes may indicate an anomaly in the efficient markets because of these variables.

Another interesting idea for research might include an actual experimental setup, rather than the analysis of past data. So far, all that has been done has dealt with real market movements in the past. It may be worthwhile to obtain consent from subjects to test them in mood and buying attitudes under different testing situations. Perhaps a stock simulation could be played over a given period of days while the subject is in a room with different climatic constants. For example, one subject might be kept in a room that is partially lit with a great deal of artificial sunlight, whereas another subject might be asked to complete the simulation after a given amount of time in relative darkness. These are just some of the possibilities for further research into the area of mood based investing because of climatic conditions.

Conclusion:

After all the research, the dot com bubble and a Nobel prize, it may be quite a while before behavioral investing is really taken very seriously. A large part of this comes from the fact that results in behavioral investing are mixed and the psychology and sociology behind this investing is not a hard science. Some may argue that it's more of an art than a science. Unlike mathematics or physics or chemistry, social sciences have very few scientific laws. There is great controversy among even the brightest researchers in each social science because there are no proofs. There is virtually no way to show that something is true and will always hold true because behavior is dynamic and to some degree unique from individual to individual. To this day, some people still believe that psychology cannot be a science. It cannot be studied because there is too much variation.

Behavioral investing, because it relies so heavily on psychology, may end up the same way. It may never take hold because it is difficult to prove. Perhaps it is all hot air and some people whom gained from it were just very lucky, but we cannot know that until it is researched a great deal more.

As for behavioral investing based on people's reactions to climatic conditions, it appears as though all that makes a noticeable difference in returns is sunlight, based on the "Good Day Sunshine..." study. This study did find relationships between some climatic conditions and volume but this is much less useful than a relationship with actual returns would have been. Perhaps with a deeper look at the subject, we will find better ways to apply predictable, psychological mood knowledge to investing, but as for right now, it is difficult to see. Does that mean that we should embrace the efficient markets hypothesis? Not necessarily. Challenging something is often the best way to understand and appreciate it. Perhaps only time and further thought into the area of efficient markets

and behavioral investing can truly tell us how it all works. Until then, we can only speculate.

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