Time Series Analysis of Mercury's Planetary Cycle and Stock Market Indexes

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Executive Summary

This report delves into the correlation between Mercury's planetary cycle and the performance of various stock market indices. As Mercury makes its way around the sun, there is a period of time where it appears to be moving farther away from Earth, which is Mercury retrograde. By scrutinizing stock market indices' behavior and comparing their performance before and during retrograde periods, discernible cyclic patterns can emerge. Employing a combination of time series analysis and the application of cycles can assist in identifying patterns and forecasting the stock market returns. Astrologically, Mercury retrograde holds significance, as astrologers believe that it can disrupt communication and technology. Astrologers advise against making big decisions or signing contracts during this period because communication can go awry. There is doubt about astrology as it has become a social element in today's society. Although its validity is debated, addressing its significance and applicability becomes a data science question.

After preparing the data to ensure stability in the analysis, a conclusion can be drawn that stock market returns experienced a decline during retrograde phases between 2018 and 2023. While overall market returns exhibited an upward trend, consistent downturns emerged during retrograde periods. The data indicates increased volatility during these phases, although not consistently. Outliers notably impact the dataset, skewing averages towards extreme values. For investors and traders, this carries significance as they can anticipate diminished returns in retrograde periods, entailing

greater risk in business decisions and investments. An integral discovery is that even after removing the outliers, the mean and median of simple returns during retrograde remained lower than those before. In essence, it is clear that Mercury retrograde consistently aligns with reduced returns.

Introduction

The position of the planets have been involved with scientific advancements since ancient times, while the planetary cycles have served as a predictive tool across a range of disciplines, including astrology and astronomy. Astrology studies the movement of the planets through the zodiac to anticipate earthly and human events. Astrologers believe that using planetary transits can help predict future events, such as political changes, climate, natural disasters (*Mercury Retrograde* 2018). Astronomers are able to understand the behavior of celestial bodies and natural phenomena through planetary cycles. Astronomers can predict the precise positions of the planets and other celestial bodies through mathematics. For centuries, humans have always been narrative beings constantly trying to make sense of the past, present, and future whether it is through astronomic cycles or technical analysis. Data of planetary cycles compiled over thousands of years is data science in its earliest form and astrology is described as “an expression of a deeply mathematically deterministic view of the human condition” (Ball, 2020). Technical advancements have allowed humans to stop relying on the stars to predict specific events, but that does not mean there are astrological phenomena that can mimic the cycles of human affairs.

Astrological beliefs played an important role in human history, world views, social culture, language, and more. In the article, *How Astrology Paved the Way for Predictive Analytics,* by Philip Ball states that since early civilizations, humanity has turned its gaze to the stars for guidance and navigation. In fact, the creation of constellation maps predates the creation of world maps (Ball, 2020). Furthermore, the article highlights an intriguing fact that 17th-century German mathematician Johannes Kepler, renowned for discovering the laws of planetary motion, engaged in calculating horoscopes for the Holy Roman Emperor Rudolf II (Ball, 2020). In addition, Ball cites Alexander Boxer, an American data scientist with a doctorate in physics, who suggests the motivation for planetary observations stemmed from astrology (Ball, 2020). Relating this practice to financial markets is a newer phenomenon, however, recent literature has unveiled intriguing parallels between planetary cycles and the behavior of the stock market.

Technical analyst Bill Meridian employs astronomical cycles to forecast events in the market. Renowned for his research, Meridian studies the correlation between planetary cycles and time series data. In his article, *The Development of Planetary Stock Market Forecasting*, he reveals that he began to analyze stock prices and planetary cycles after learning that the rhythms of the stock price have a similar length to planetary periods (Meridian, 2022). He designed computer software in the 80s called Astro Analyst to assist in his research, where he observed Jupiter's 11.84 years long planetary cycle to the stock market (Meridian, 2022). Meridian’s study delved into the stock market’s percent change in price as Jupiter navigates through the zodiac. After graphing the average stock price between 1915 and 1987, covering six cycles, he characterized the behavior stating that there was an approximate rise of seven percent from its initial point from Aries to its peak in Taurus. Subsequently, it drops abruptly until it reaches Virgo, only to face another decline into the latter stages of Libra. It then makes a consistent rally through Scorpio and chops sideways until it gets to mid-Pisces. At this point, it rallies upwards as it enters back into Aries. (Meridian, 2022).

To demonstrate the consistency and unwavering nature of this trend, Meridian graphs the composite of sixteen cycles, Jupiter's passage around the sun from 1789 to 1988, of the Dow Jones Industrial Average's monthly stock averages. Remarkably, he found consistent behavior between the two graphs, despite some minor variations observed around the Libra region (*see figures below*) (Meridian, 2022). Furthermore, whether his observations spanned 50, 100, or 200 year periods, the astrological market indicators consistently remained prevalent.

Figure 1:Jupiter's passage from 1915 to *1987*

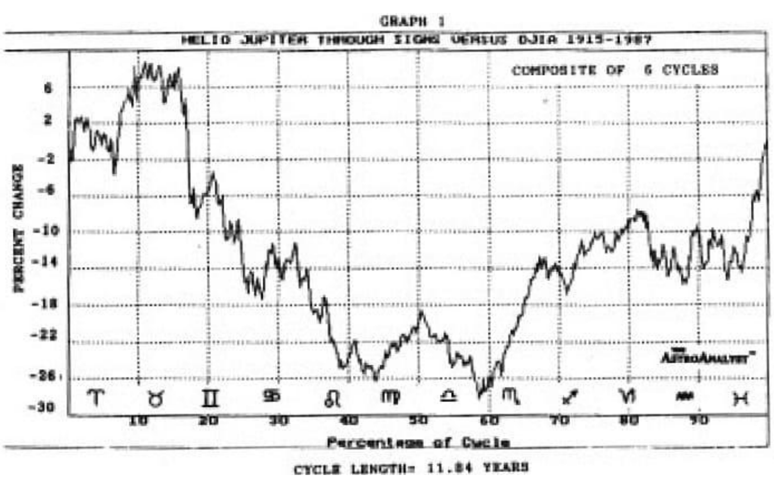
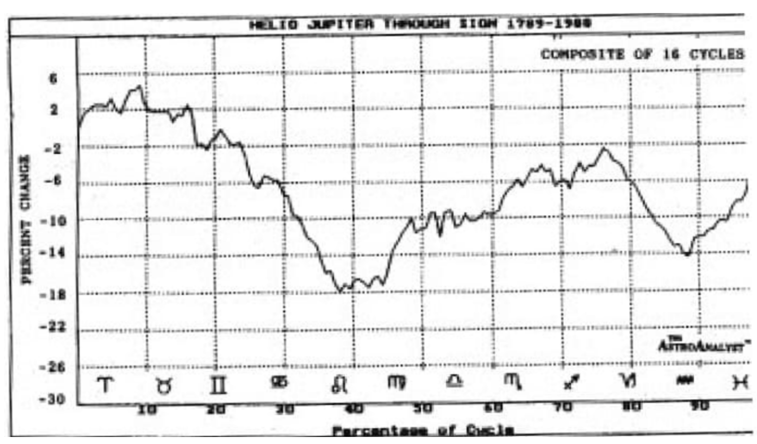


Figure 2: Jupiter's passage from



1789 to *1988*

Additional literature about the correlation between planetary cycles and financial markets is described in the research paper *Long Live Hermes! Mercury Retrograde and Equity Prices*, published in May 2020 by Yanling Qi, Hang Wang, and Bohui Zhang. Qi is from the Department of Health Care Administration at California State University, Wang is from the School of Banking and Finance at UNSW Business School, and Zhang is from Shenzhen Finance Institute at the Chinese University of Hong Kong. Their study scrutinizes the impact of Mercury Retrograde on stock market returns, examining market indexes in 48 countries. Notably, their findings indicate that the average market returns during Mercury Retrograde periods are approximately 3.22% lower yearly compared to other periods (Qi et al., 2020).

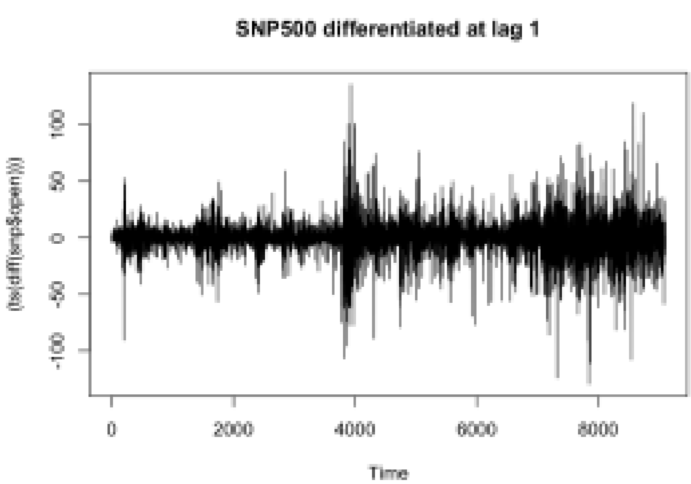
According to astrology, Mercury represents commerce, travel, traffic, communication, logic, rationale, and transportation. Mercury retrograde is a planetary transit that occurs when Mercury laps Earth. Since a year on Mercury is 88 Earth days, it seems to move in a backward trajectory relative to Earth, occurring approximately three times a year for three weeks (*Mercury Retrograde* 2018). Mercury retrograde holds significance as astrologers believe Mercury's energy during this phase can cause confusion and disruption in the areas related to communication and technology (*Mercury Retrograde* 2018). Consequently, communication goes awry and given that equity trading and investing involve decision-making, astrologers counsel investors to refrain from enacting business plans – like signing contracts or committing to investments – during retrograde periods.

Drawing inspiration from *The Development of Planetary Stock Market Forecasting* and *Long Live Hermes! Mercury Retrograde and Equity Prices,* this research aims to uncover significant patterns in the stock market during Mercury retrograde periods. The research utilizes diverse stock market indices, including S&P 500, NASDAQ, Dow Jones Industrial Average, and BANKNIFTY, all sourced from TradingView. Acting as a social network and charting platform, TradingView allows investors and traders to monitor global markets comprehensively. This platform facilitates detailed analysis of stock performance across varying time frames from minute-by-minute to daily, allowing for meticulous observation. Moreover, it is a dependable source to extract precise market data. The focal point of this research lies in studying the performance of multiple stock indexes, before and during retrograde phases, and examining Mercury's planetary cycle alongside stock market returns.

Data Analysis and Experimental Design

Stock market indexes exhibit more stability compared to individual company stocks and are likely to have cyclical trends. By focusing on these indices, the susceptibility to media or news-induced volatility is diminished. Nevertheless, the stock market indices would illustrate the Mercury Retrograde effect if it is present. This research hypothesizes that the stock performance of the observed indices will demonstrate comparatively lower during the retrograde period than in preceding periods. The data was sampled hourly from January 2018 - January 2023, considering the 6.5-hour trading window of approximately 252 days of the year. The data sets originally contained approximately 9100 observations and the following variables: time, open, high, low, close, and volume. Upon downloading the data and importing it into the R, the time values were in UNIX code format and it was necessary to convert these values into “MM-DD-YYYY” format for readability. Furthermore, considering the hourly sample rate, I translated the UNIX code into a timestamp format “MM-DD-YYYY hour:minute:second”. There were not any missing values, negating the need for data removal. The open, high, low, and close signify the stocks’ daily share price at different intervals of the day.

After converting the time series into time series objects in R, it is possible to visually check for stationarity, indicating there is a constant mean and variance – and more strictly speaking, constant covariance. Nonstationary data embodies a trend and/or a seasonal pattern. By plotting the open prices, the plots reveal that the datasets are inherently non-stationary. It is necessary to transform the data by computing the first difference, removing the trend and/or seasonal pattern. After doing this and plotting the transformed data, the data appears to oscillate around mean of 0 with constant variance.



To verify this further, it is ideal to use the Augmented Dickey-Fuller (ADF) Test to check for stationarity. Since there are multiple variables associated with each time series, the ADF test considers only the close variable to ensure the model is a univariate time series. The null hypothesis claims there exists a unit root, signifying that the time series is nonstationary, whereas the alternative hypothesis is that there is no unit root and the time series is stationary. Applying this test to all four datasets after converting them into time series objects results in p-values greater than 0.05: 0.57, 0.89, 0.27, and 0.56, indicating to fail to reject the null hypothesis. However, it is ideal to use a stationary time series model for forecasting. Therefore, after differentiating the data at lag 1 and applying the ADF test, the p-values appear to be 0.01, smaller than 0.05, so it is reasonable to reject the null hypothesis.

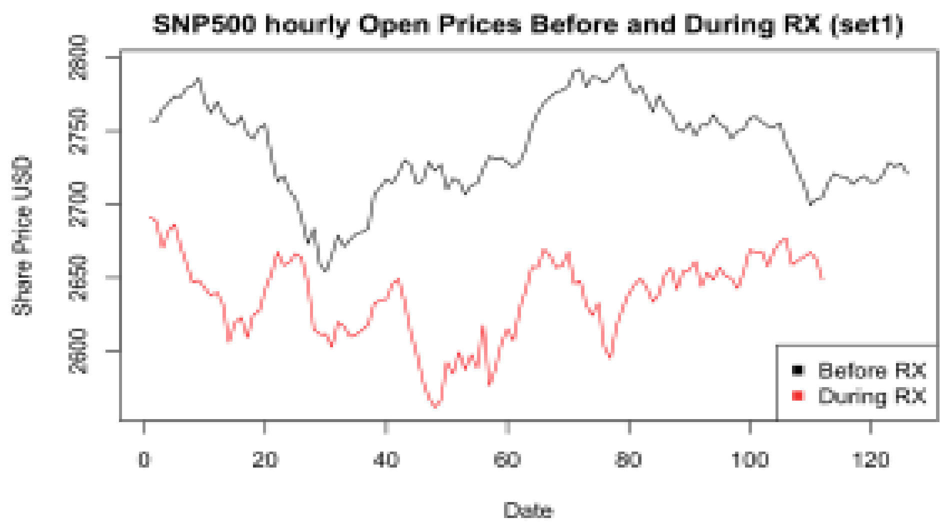
The objective is to meticulously compare each set one-by-one in a sequential manner, discerning patterns to reveal whether the simple returns are lower, higher, or consistent during retrograde. The null hypothesis of this study posits that Mercury Retrograde has no discernible impact on market returns. The retrograde periods for 2018 were March 22 - April 15, July 26 - August 19, and November 16 - December. Subsequently, for 2019, these intervals were March 5 - 28, July 7 - August 1, and October 31- November 2. For 2020, the dates are February 16 - March 9, June 18 - July 12, and October 13 - November 2. Transitioning into 2021, the periods occurred on January 30 - February 20, March 29 - June 22, and September 26 - October 18. Lastly, in 2022 Mercury Retrograde occurs in January 14 - February 3, May 10 - June 2, September 9 - October 2, and December 29 - January 18 of 2023.

It was necessary to further clean and subset the data sets before and during each Mercury retrograde interval for comparison. This forms new data sets corresponding to the pre-retrograde and retrograde intervals. Each set is defined as a three-week span before the onset of Mercury retrograde and the concurrent three-week retrograde period. Variations in the number of observations in these intervals depend on the amount of business days within the period. Given that Mercury retrograde occurred 16 times during 2018 - 2022, there are 64 sets. By also taking the first difference, the simple returns were calculated before and during retrograde to quantify momentary gain or loss.

To focus on each individual dataset, the mean of the simple returns of the SNP500 before and during are -9.801e-05 and -0.0001727, respectively. Similarly, the corresponding medians are 0.0003685 and -8.324e-05. Transitioning into NASDAQ, the means before and during are 1.461e-05 and -0.0002786, with respective medians 0.0006169 and -0.0008920. For the Dow Jones Industrial Average, the means are -0.0001920 and -0.0001010, with corresponding medians -2.319e-06 and -1.402e-05. Lastly, the simple returns of BANKNIFTY before and during retrograde are -0.0003522 and 0.0003816 with medians -0.0001492 and 0.0005207.

A discernible trend emerges and indicates that some datasets portray a lower median during retrograde, while others do not. However, it is important to consider that the presence of outliers can skew the mean. For example, in set 1, it appears that there is a stark decrease once retrograde begins, as well as a surge in volatility. Extreme volatility in some sets of retrograde occurrences can accentuate the appearance that the data is more volatile than across all of the data (*see Figure 3 below*). This particular set serves as a prime example, both visually and empirically, of lower returns during retrograde coupled with high volatility.

Figure 3: S&P 500 - Set 1



Collectively, the median of simple returns prior to retrograde stands at 6.793e-05, while the median of simple returns during Mercury Retrograde elevates 8.7471e-05. In contrast, the mean of simple returns before retrograde stands at 5.409e-05, while the mean declines to -7.394e-05 during retrograde. Remarkably, the median and mean before retrograde are similar, indicating that the data was rather stable with a decrease of 1. However, the mean and median during retrograde periods exhibit a notable disparity. The presence of extreme values during retrograde had a considerable influence on the mean, suggesting potential heightened volatility. Overall, the performance of the four stock indices indicates that, on average, market returns tend to be lower during Mercury Retrograde phases compared to usual periods.

Eliminating the outliers allows for a more accurate representation of that data. During the 5 year window, it is plausible that stock market crashes could have occurred during retrograde, potentially skewing the data towards lower values. After removing the market returns that exemplified extreme loss or gain, the mean preceding retrograde is 4.421e-05, while during retrograde, it adjusts to -0.001422. Meanwhile, the median before retrograde periods is 6.194e-05 and the median during retrograde periods shifts to -0.0003839. Interestingly, the mean and median before retrograde periods remain approximately consistent to the statistics before removing the outliers. Conversely, the mean and median during retrograde are more closely aligned, now that the outliers have been discounted. On average, retrograde periods experience heightened volatility, however this volatility is not uniformly constant. More significantly, market returns during retrograde periods are lower than preceding periods. It is noteworthy that even when the stock market indexes displayed an upward trajectory, there existed dips in its performance during retrograde periods.

Time Series Modelling and Forecasting

The Box-Jenkins methodology is an approach for time series forecasting, comprising three main steps: model identification, model estimation, and model validation. In the first step, the model identified to forecast future stock market returns is the ARIMA model. The Autoregressive Integrated Moving Average (ARIMA) model is a time series model used to forecast future values based on historical data. ARIMA models are adaptable, able to handle nonstationary and stationary data, commonly used to forecast stock market data.

The ARIMA model has three parameters: p, d, and q, with a max of 5 for each parameter. They correspond to the autoregressive order, the differencing order, and the moving average order, respectively (Chatfield, 2019). The autoregressive order denotes the number of lagged values used to predict the next value in the time series and can also be determined by analyzing the autocorrelation function (ACF) plot (Chatfield, 2019). In other words, it is the number of past time points used for prediction. The differencing order is the number of times the data was differenced to acquire stationarity, which was part of the pre-processing step of the data (Chatfield, 2019). With that said, the data can be easily modeled without the trend or seasonality component. The moving average order is the number of past errors used to predict the next variable, which can also be determined by analyzing the partial autocorrelation function (PACF) plot (Chatfield, 2019).

In the second step, the model parameters are estimated using the auto.arima() function. This function employs various methods to determine the optimal values for p, d, and q. It examines different configurations for these parameters to identify the most suitable setup for an ARIMA model. For the S&P 500 dataset, the optimal values are 1, 0, and 1, for p, d, and q, respectively. The best model for the NASDAQ dataset had the following parameters: 0, 0, and 4.. The best model for the Dow Jones Industrial Average was the ARIMA model with parameters: 1, 0, and 1. Lastly, for BANKNIFTYwas the ARIMA model with parameters: 0, 0, and 0.

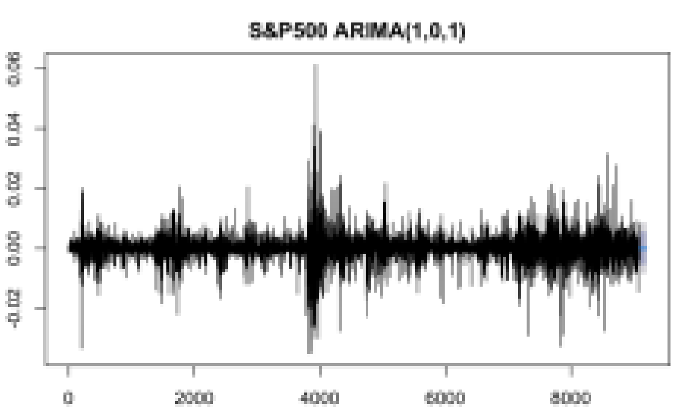
The final stage involves model evaluation, gauging accuracy using AIC and BIC. AIC stands for Akaike Information Criterion, defined as AIC = -2 * log-likelihood + 2 * p (where p is the parameter count). BIC, Bayesian Information Criterion, is defined as BIC = -2 * log-likelihood + log(n) * p (where n is sample size). Lower AIC and BIC values signify better-fit models.

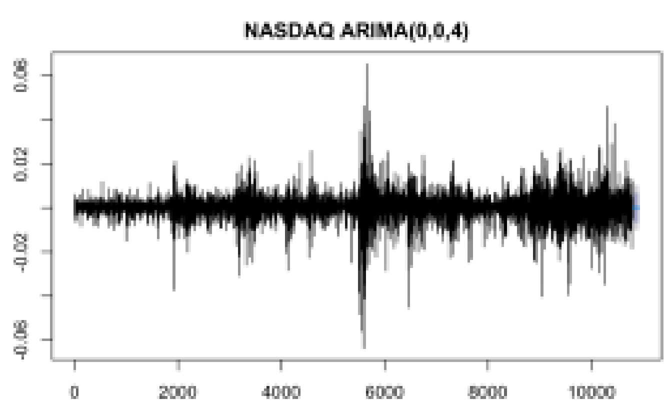
In this case, the ARIMA(1, 0, 1) has an AIC of 73200 and a BIC of -73182. The

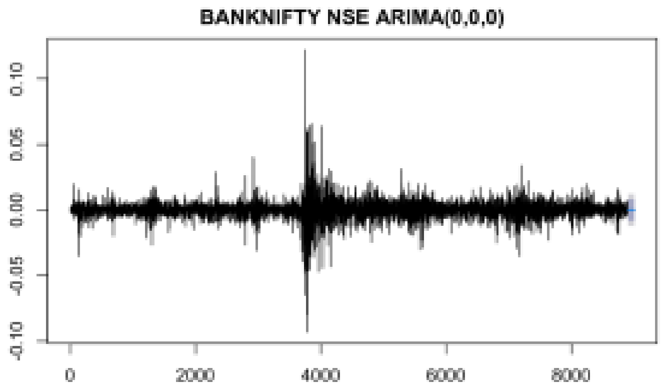
ARIMA(0, 0, 4) has an AIC of -73334 and a BIC of -73313. The ARIMA(1, 0, 1) has an AIC of -73334.39 and a BIC of -73313.04. The ARIMA(0, 0, 0) has an AIC of -65017.66 and a BIC of -65010.57.

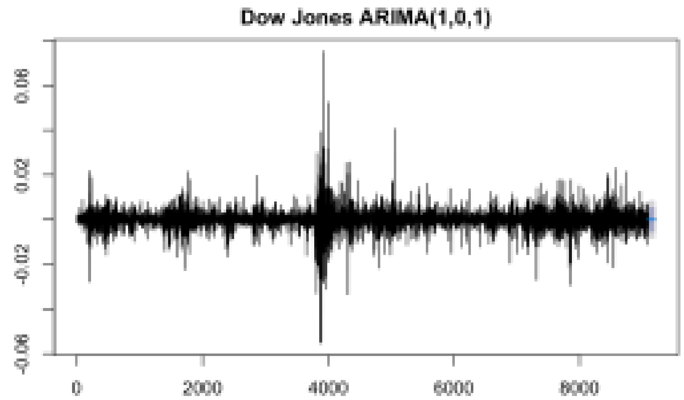
For instance, ARIMA(1, 0, 1) displays an AIC of 73200 and BIC of -73182. ARIMA(0, 0, 4) features AIC of -73334 and BIC of -73313. ARIMA(1, 0, 1) has AIC of -73334 and BIC of -73313. Lastly, ARIMA(0, 0, 0) presents AIC of -65017 and BIC of -65010.Notably, during modeling, the forecasted values' blue line showed limited variability. Despite using the auto.arima() function to identify optimal parameters, potential model discrepancies could arise from outliers, insufficient data, incorrect model selection, etc. Nonetheless, AIC and BIC values indicate that chosen parameters are, infact, optimal.

Furthermore, when attempting a Seasonal Autoregressive Integrated Moving Average (SARIMA) model to account for seasonal patterns, the AIC and BIC values exceeded those of the ARIMA model. This implies that despite plotting issues in forecasted values, the ARIMA model still remains the most ideal. Moreover, SARIMA forecasted plots exhibited linear patterns. To bolster accuracy assessment, checkresiduals() function plots are provided.









Discussion and Conclusions

In my research, I observed Mercury's planetary cycle, particularly during retrograde, alongside various stock market indexes. My findings challenges the notion that astrology lacks applicable in modern science. By scrutinizing Mercury's planetary cycles and observing patterns in the stock market indexes, I reached a substantiated conclusion about the Mercury Retrograde effect.

After analyzing the means and medians of each dataset, I noticed mixed results- some datasets showcased the Mercury retrograde effect, while others did not. Considering the data with its outliers allowed me to make conclusions about its consistency and identify potential skewing factors. After removing the outliers, data preceding retrograde periods exhibited stability with mean and median. However, consistent data indicated lower market returns during retrograde periods. This aligns withthe Mercury retrograde effect, the stability would be disrupted during retrograde periods. Furthermore, I did observe higher volatility on average during retrograde periods. This could be significant to traders and investors as they can anticipate lower

returns during retrograde, as well as higher volatility. Even though the volatility was not consistent throughout the dataset, there existed highly volatile periods that skewed the mean drastically. I believe this is important to note because the data before retrograde periods did not display nearly as much volatility as retrograde periods.

There were some errors in my forecasting exercise as the ARIMA model plots were showing little to no variability. Despite following the best suited parameter values from the auto.arima() function, there was a problem with how the ARIMA model was capturing the data. Even with trying to model with SARIMA, there were still errors with plotting the forecasted values. Until that point, the steps I took to forecast future returns seemed to be on track as I evaluated the AIC and BIC for each dataset. Overall, I think my research was successful and the statistics computed were able to conclude information on the data's consistency and volatility during retrograde periods. There are visible discrepancies in the forecasted plots, so the forecasting can be improved.

In summary, the data showcases the Mercury retrograde effect. This research exemplifies insightful information regarding time series data and the application of planetary cycles. Regardless of one's astrological beliefs, Mercury retrograde simply allows us to choose a particular time window to observe undeniable patterns. In today's society, astrology is linked to the daily horoscopes in magazines or in social media, but historically, it played a crucial role in navigating the world around us. It's imperative to clarify that my research has no intention in persuading individuals to unequivocally embrace astrology as an absolute reality. Rather, its primary aim is to emphasize its use as a pivotal tool to decipher and comprehend the intricate complexities of the world around us.

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