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Programming Data Science

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The Historical Price Data of Bitcoin

Bitcoin is a volatile cryptocurrency that has been traded on digital platforms since its inception in 2011. The digital currency works on a platform called blockchain, which keeps track of transactions made with Bitcoin. The prices of Bitcoin changed dramatically due to supply and demand, competition with other cryptocurrencies, regulatory changes, and media. Monetary policy, inflation rates, and economic growth do not affect Bitcoin since it's not issued by a central bank or backed by a government. The first Bitcoin was mined on January 3rd, 2009, and the first transaction happened on January 12th, 2009, when Satoshi Nakamoto sent 10 Bitcoin to Hal Finney. Since then, Bitcoin became a worldwide phenomenon by providing opportunities to individuals and having a long-lasting impact on the economy. Due to its high value, Bitcoin can reduce the cost of cost-border transactions, which benefits international trade. Bitcoin's capped supply has the potential to control inflation. From 2010-2013, Bitcoin had the first big boom when its value went from cents to at least $1000. The Cyrus Banking crisis of 2013 caused people to become motivated in digital assets. In 2010, 10,000 BTC was used to purchase 2 pizzas, showing that it can be used as a commodity value. Fast forward to 2017, Bitcoin achieved mainstream headlines when it was valued at $20,000 after a gain in media coverage and the growth of crypto exchanges. From 2017-2019, the value of Bitcoin decreased tremendously from $20,000 to $3000 since there were investigations on Initial Coin Offering due to their illegal

activities. The COVID-19 pandemic created a lockdown in the United States in March 2020, which negatively affected Bitcoin as it crashed to $4000. However, Bitcoin gained so much value in late 2020 due to more money printing and low interest rates to provide a hedge against inflation. Bitcoin ETFs were invented in Canada and the United States. The cryptocurrency decreased in value during 2022 when it fell from $69,000 to $16,000 because of rising inflation and interest rates. This was impacted by the war between Russia and the Ukraine in February 2022. There were financial consequences in both countries as it impacted foreign exchange rates. Ukrainians used Bitcoin to save money when banks allowed limited withdrawals. Throughout 2022, Ukraine obtained over $100 million in crypto donations to support family needs. Russia's central bank stopped working which led to investors lean more into Bitcoin since it wasn't regulated by the government. The war rose food and energy prices which affected inflation. There was recovery from 2023-2025 since there was the Bitcoin halving, ETFs approval, and institutional interest. A problem that Bitcoin has is that it's extremely volatile because the price is determined by supply and demand, media influence, and actions made by investors. There are less than 20 million Bitcoin as of November 2025, impacting the market value. Media outlets and opinions made by investors cause short-term swings in Bitcoin. There can be sudden price changes in Bitcoin after the release of regulatory news and uncertainty. Bitcoin became illiquid due to failing bank reserves which causes investors to be less likely to invest in riskier assets. An increase in regulation can create market volatility, causing Bitcoin's downward spiral. An investment risk is another challenge that investors encounter because they may panic sell since they are worried about Bitcoin falling in value. In conclusion, Bitcoin is the digital currency that completely transformed what we call Metaverse. Here below is the program that shows the historical price data set of Bitcoin.

```
# ==========================================

# 1. IMPORT LIBRARIES

# ==========================================

import os

import pandas as pd

import matplotlib.pyplot as plt

# ==========================================

# 2. FIND YOUR CSV FILE AUTOMATICALLY

# ==========================================

# Get your Downloads folder dynamically

downloads_path = os.path.join(os.path.expanduser("~"), "Downloads")

# Find any CSV with "Bitcoin" in its name

bitcoin_files = [f for f in os.listdir(downloads_path) if "bitcoin" in f.lower() an

if not bitcoin_files:

    raise FileNotFoundError("No CSV file containing 'Bitcoin' found in your Downloa

# Use the first match

file_path = os.path.join(downloads_path, bitcoin_files[0])

print("
```

✅

Found file:", file_path)

==========

3. LOAD YOUR DATA

==========

df = pd.read_csv(file_path)

print("Preview of the dataset:")

display(df.head())

==========

4. CLEAN AND PREPARE DATA

==========

Clean column names

df.columns = df.columns.str.strip()

Detect date column

date_col = [col for col in df.columns if 'date' in col.lower()][0]

df[date_col] = pd.to_datetime(df[date_col])

df = df.sort_values(by=date_col)

Identify price columns (Open, High, Low, Close)

```
price_cols = [col for col in df.columns if any(x in col.lower() for x in ['open', '

print("\nDetected price columns:", price_cols)

# ==========================================

# 5. PLOT THE HISTORICAL PRICES

# ==========================================

plt.figure(figsize=(12, 6))

for col in price_cols:

    plt.plot(df[date_col], df[col], label=col.capitalize(), linewidth=2)

plt.title("Bitcoin Historical Prices", fontsize=16)

plt.xlabel("Date", fontsize=12)

plt.ylabel("Price (USD)", fontsize=12)

plt.legend()

plt.grid(True)

plt.tight_layout()

plt.show()
```

✅ Found file: C:\Users\Mihir Patel\Downloads\Bitcoin BEP2 (1) (1).csv
Preview of the dataset:

	Date	Open	High	Low	Close	Volume	Currency
0	6/18/2019	9128.269531	9149.763672	8988.606445	9062.045898	952850	USD
1	6/19/2019	9068.174805	9277.677734	9051.094727	9271.459961	131077	USD
2	6/20/2019	9271.567383	9573.689453	9209.416992	9519.200195	83052	USD
3	6/21/2019	9526.833984	10130.935550	9526.833984	10127.998050	76227	USD
4	6/22/2019	10151.890630	11171.013670	10083.189450	10719.981450	84485	USD

Detected price columns: ['Open', 'High', 'Low', 'Close']


```
# ============================================

# 1. IMPORT LIBRARIES

# ============================================

import os

import pandas as pd

import matplotlib.pyplot as plt
```

```
# ==========================================

# 2. AUTO-LOCATE YOUR CSV FILE

# ==========================================

downloads_path = os.path.join(os.path.expanduser("~"), "Downloads")



# Find any CSV with "Bitcoin" in its name

bitcoin_files = [f for f in os.listdir(downloads_path) if "bitcoin" in f.lower() and

f.endswith(".csv")]



if not bitcoin_files:

    raise FileNotFoundError("No CSV file containing 'Bitcoin' found in your Downloads folder.")



# Use the first found Bitcoin CSV

file_path = os.path.join(downloads_path, bitcoin_files[0])

print("✅ Found file:", file_path)



# ==========================================
```

```
# 3. LOAD THE DATA

# ============================================

df = pd.read_csv(file_path)

print("Preview of dataset:")

display(df.head())



# ============================================

# 4. CLEAN AND PREPARE DATA

# ============================================

df.columns = df.columns.str.strip()  # remove spaces

date_col = [col for col in df.columns if 'date' in col.lower()][0]

df[date_col] = pd.to_datetime(df[date_col])

df = df.sort_values(by=date_col)



# Identify price columns

price_cols = [col for col in df.columns if any(x in col.lower() for x in ['open', 'high', 'low',

'close'])]



print("\nDetected price columns:", price_cols)
```

```
# ==========================================

# 5. PLOT SEPARATE GRAPHS

# ==========================================

for col in price_cols:

    plt.figure(figsize=(10, 5))

    plt.plot(df[date_col], df[col], color='orange', linewidth=2)

    plt.title(f"Bitcoin {col.capitalize()} Price", fontsize=16)

    plt.xlabel("Date", fontsize=12)

    plt.ylabel("Price (USD)", fontsize=12)

    plt.grid(True)

    plt.tight_layout()

    plt.show()
```

Found file: C:\Users\Mihir Patel\Downloads\Bitcoin BEP2 (1) (1).csv
Preview of dataset:

	Date	Open	High	Low	Close	Volume	Currency
0	6/18/2019	9128.269531	9149.763672	8988.606445	9062.045898	952850	USD
1	6/19/2019	9068.174805	9277.677734	9051.094727	9271.459961	131077	USD
2	6/20/2019	9271.567383	9573.689453	9209.416992	9519.200195	83052	USD
3	6/21/2019	9526.833984	10130.935550	9526.833984	10127.998050	76227	USD
4	6/22/2019	10151.890630	11171.013670	10083.189450	10719.981450	84485	USD

Detected price columns: ['Open', 'High', 'Low', 'Close']

In the first program, I imported libraries and found my csv file automatically. I loaded my data to read the csv into Pandas Data Frame, showing the first 5 rows so I can verify it properly. The program found the column that contains the date and changed it to the type of date time. The program searches for all column names and collects any that are open, high, low, and close. After collecting all the information in the columns, it plots the historical prices by creating a 12x6 plot window and it loops through each price column such as open, high, low, and close. It draws a line graph where the x-axis is the date column, the y-axis is the selected price column, label is the column name, and the linewidth describes the thickness of the line. I used visualization because it is useful when exploring data as explained in Chapter 10. Matplotlib is the base for

other libraries such as Seaborn. Many programmers use matplotlib to create figures and axis, which is included in charts. I utilized several equations that I have in methods. The first equation that I incorporated is the first derivative also known as the rate of change. The equation to the left

$$f'(t) \approx P_t - P_{t-1}$$

approximates how quickly Bitcoin's price changes daily. If the first derivative is positive, the price is increasing. If it is negative, the price is decreasing. P(t) is the price of Bitcoin on day *t* and f(t) is the rate of change. Furthermore, the second derivative is placed in the method, showing the acceleration of price changes.

$$f''(t) \approx f'(t) - f'(t-1)$$

The equation you see above shows how fast the rate of change is happening. It's useful for detecting trend reversals. A large positive value shows that Bitcoin is accelerating, whereas a large negative value indicates that Bitcoin is decelerating. A calculus technique that is utilized is log returns, revealing the instantaneous rate of change. The idea is that it comes from the continuous compounding formula.

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

$$\ln\left(\frac{P_t}{P_{t-1}}\right) \approx \frac{dP}{P}$$

The logarithmic return is a continuous time derivative that is related to price. The advantages that this equation carries are that it measures volatility, removes the issues of scale when prices are

large, and that it's more stable than percentage returns. The rolling volatility is the standard deviation of log returns. In financial calculus, the volatility is the derivative of price's variance.

$$\sigma = \sqrt{E[(r_t - \bar{r})^2]}$$

The equation reveals the large difference in prices are in a 30-day window. Bitcoin has more volatility in stocks, and this formula shows a risk profile. The moving average formula shows the integral approximation. The moving average approximates the integral.

$$MA = \frac{1}{n}\sum_{t=1}^{n} P_t \approx \frac{1}{b-a}\int_a^b P(t)\,dt$$

The equation explains the long-term trends. When prices are higher than the moving average, it indicates an upward trend. When prices are lower than the moving average, it indicates a downward trend.

```
import yfinance as yf

import pandas as pd

import numpy as np

import matplotlib.pyplot as plt


btc = yf.download("BTC-USD", start="2015-01-01", end="2025-01-01")
```

```
btc.head()


# Price

btc['Price'] = btc['Close']


# First derivative (discrete approx)

btc['First_Derivative'] = btc['Price'].diff()


btc['Second_Derivative'] = btc['First_Derivative'].diff()


btc['Log_Return'] = np.log(btc['Price'] / btc['Price'].shift(1))


btc['Rolling_Volatility'] = btc['Log_Return'].rolling(window=30).std()


btc['MA30'] = btc['Price'].rolling(window=30).mean()


plt.figure(figsize=(12,5))

plt.plot(btc['Price'])
```

```
plt.title("Bitcoin Historical Price")

plt.xlabel("Date")

plt.ylabel("USD")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['First_Derivative'])

plt.title("First Derivative of Bitcoin Price (Rate of Change)")

plt.xlabel("Date")

plt.ylabel("Δ Price")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Second_Derivative'])

plt.title("Second Derivative (Acceleration of Price Movements)")

plt.xlabel("Date")
```

```
plt.ylabel("Δ² Price")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Log_Return'])

plt.title("Bitcoin Log Returns (Instantaneous Rate of Change)")

plt.xlabel("Date")

plt.ylabel("Log Return")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Rolling_Volatility'])

plt.title("Bitcoin 30-Day Rolling Volatility")

plt.xlabel("Date")

plt.ylabel("Volatility")

plt.grid(True)
```

```
plt.show()


plt.figure(figsize=(12,5))
plt.plot(btc['Price'], label="Price")
plt.plot(btc['MA30'], label="30-Day MA")
plt.title("Bitcoin Price vs 30-Day Moving Average")
plt.xlabel("Date")
plt.ylabel("USD")
plt.legend()
plt.grid(True)
plt.show()
```

The program here uses calculus techniques by showing the first derivative, second derivative, logarithmic returns, rolling volatility, and moving average.

```
import yfinance as yf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt


btc = yf.download("BTC-USD", start="2015-01-01", end="2025-01-01")
```

```
btc.head()


# Price

btc['Price'] = btc['Close']


# First derivative (discrete approx)

btc['First_Derivative'] = btc['Price'].diff()


btc['Second_Derivative'] = btc['First_Derivative'].diff()


btc['Log_Return'] = np.log(btc['Price'] / btc['Price'].shift(1))


btc['Rolling_Volatility'] = btc['Log_Return'].rolling(window=30).std()


btc['MA30'] = btc['Price'].rolling(window=30).mean()


plt.figure(figsize=(12,5))

plt.plot(btc['Price'])
```

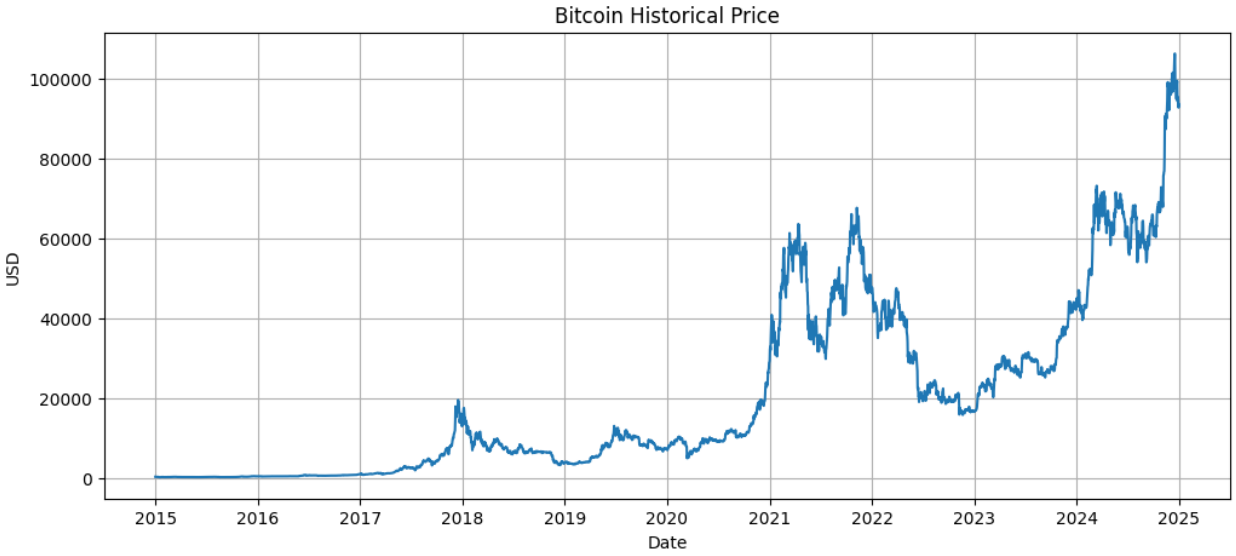
```
plt.title("Bitcoin Historical Price")

plt.xlabel("Date")

plt.ylabel("USD")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['First_Derivative'])

plt.title("First Derivative of Bitcoin Price (Rate of Change)")

plt.xlabel("Date")

plt.ylabel("Δ Price")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Second_Derivative'])

plt.title("Second Derivative (Acceleration of Price Movements)")

plt.xlabel("Date")
```

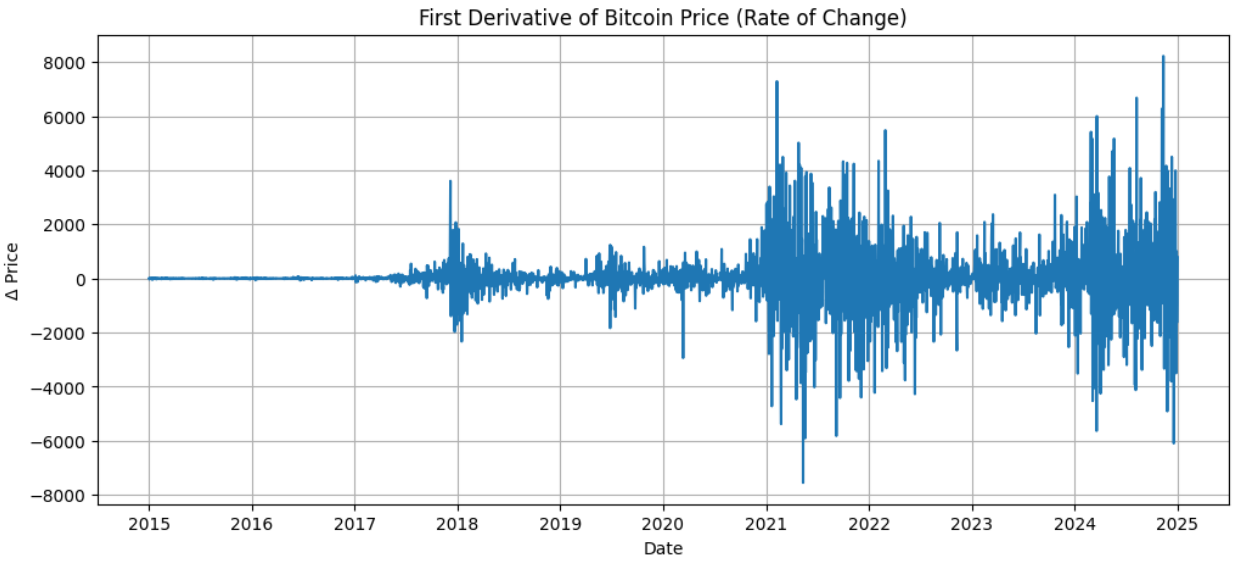
```
plt.ylabel("Δ² Price")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Log_Return'])

plt.title("Bitcoin Log Returns (Instantaneous Rate of Change)")

plt.xlabel("Date")

plt.ylabel("Log Return")

plt.grid(True)

plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Rolling_Volatility'])

plt.title("Bitcoin 30-Day Rolling Volatility")

plt.xlabel("Date")

plt.ylabel("Volatility")

plt.grid(True)
```

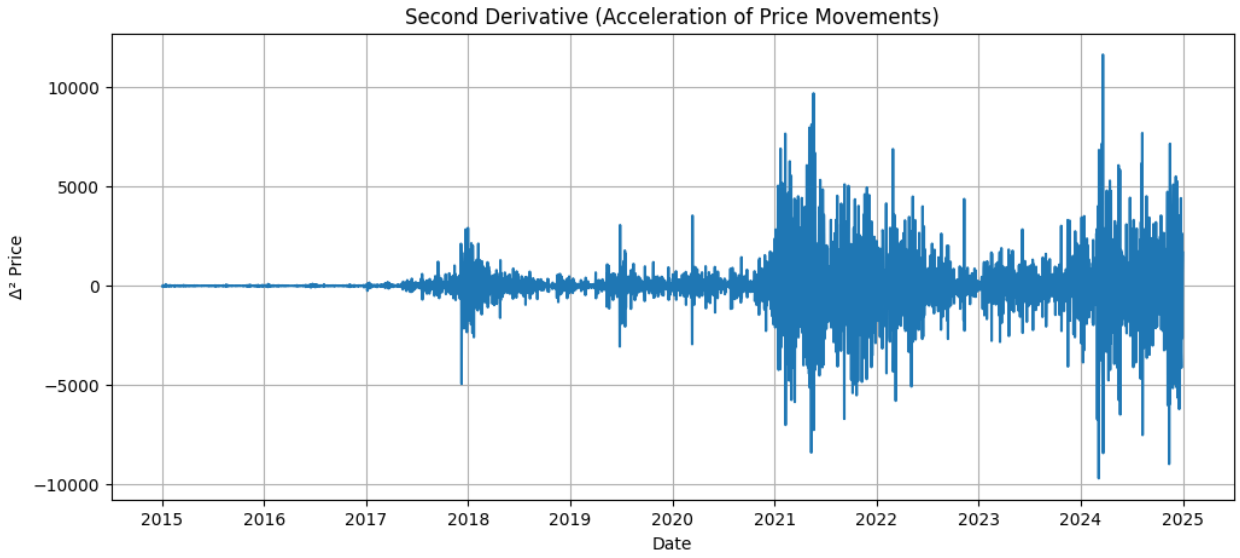
```
plt.show()



plt.figure(figsize=(12,5))

plt.plot(btc['Price'], label="Price")

plt.plot(btc['MA30'], label="30-Day MA")

plt.title("Bitcoin Price vs 30-Day Moving Average")

plt.xlabel("Date")

plt.ylabel("USD")

plt.legend()

plt.grid(True)

plt.show()
```

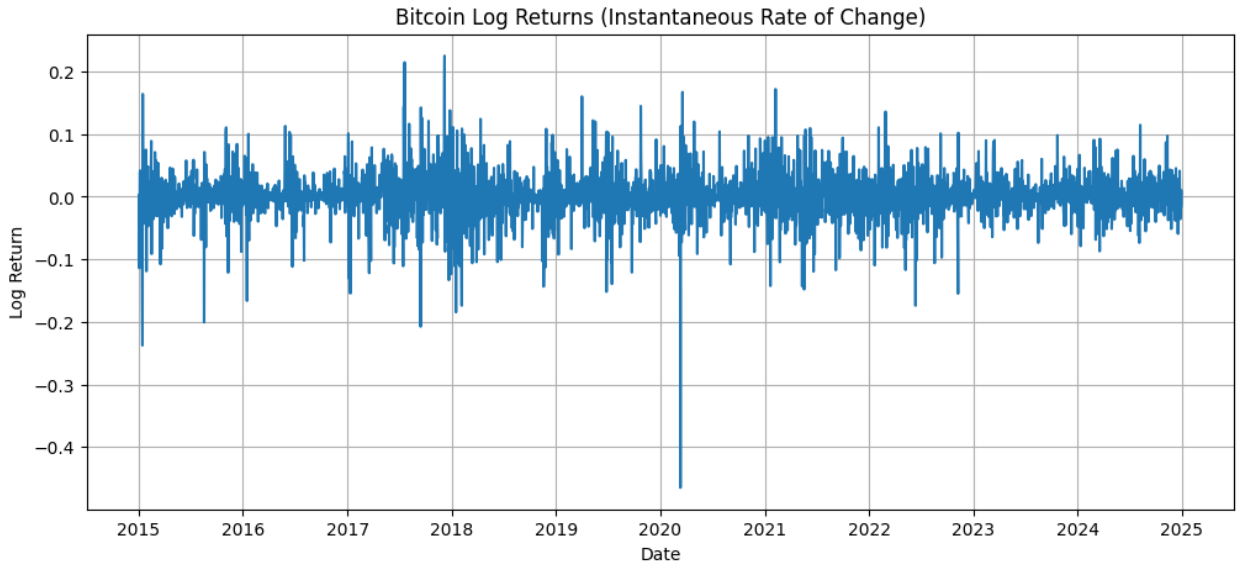
Cell output:

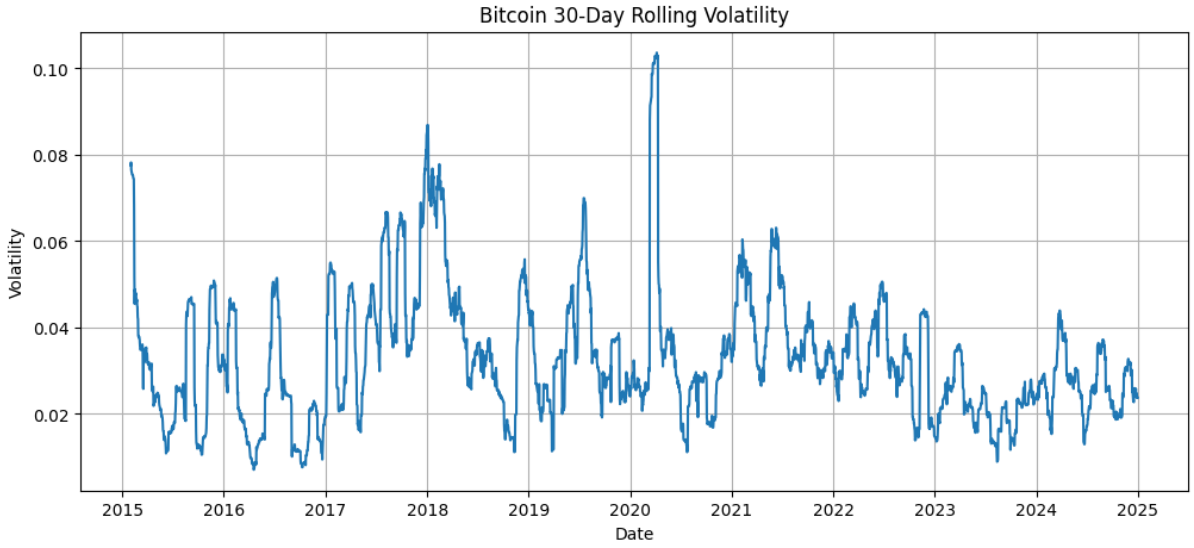
```
/tmp/ipython-input-2029803675.py:6: FutureWarning: YF.download() has changed argument
auto_adjust default to True

  btc = yf.download("BTC-USD", start="2015-01-01", end="2025-01-01")

[**********100%**********]  1 of 1 completed
```

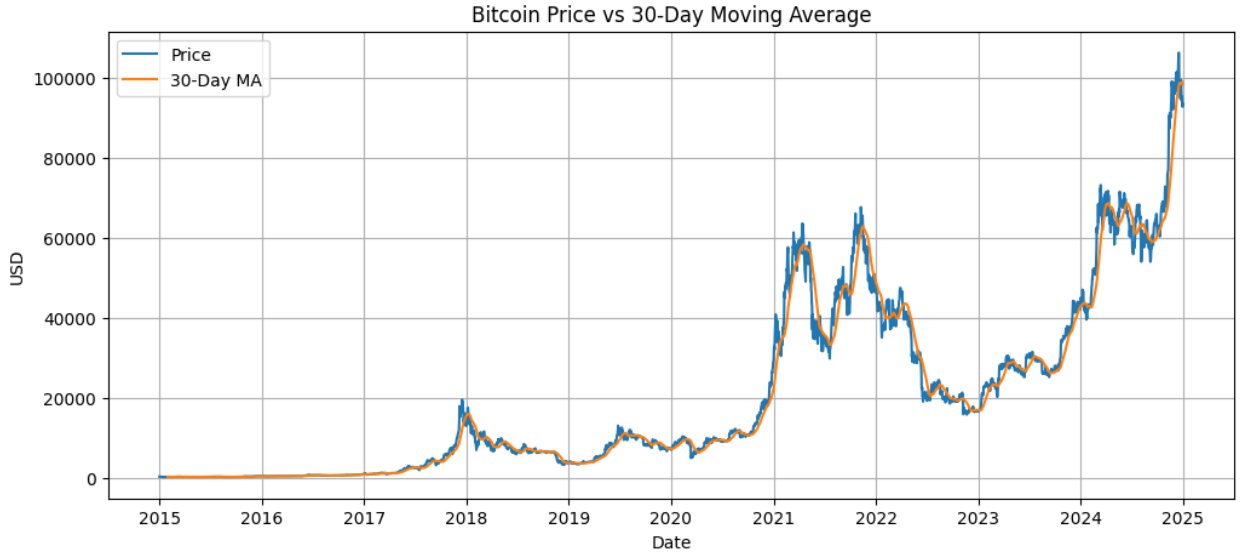

Bitcoin Historical Price
USD
100000
80000
60000
40000
20000
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date


First Derivative of Bitcoin Price (Rate of Change)
Δ Price
8000
6000
4000
2000
0
−2000
−4000
−6000
−8000
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date


Second Derivative (Acceleration of Price Movements)
10000
5000
0
−5000
−10000
Δ² Price
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date


Bitcoin Log Returns (Instantaneous Rate of Change)
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
Log Return
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date





In the program, I showed the first derivative, which are large spikes that are both upward and downward. The derivative plot is very spiky compared to stocks and ETFs because Bitcoin is extremely volatile. The second derivative displays stronger volatility as the large positive spikes means more increases in prices, and they are speeding up rapidly. The enormous negative spikes means that Bitcoin is accelerating downwards. The price of Bitcoin is that the price doesn't rise and fall. Instead, it accelerates and decelerates in an unpredictable fashion. The interpretation from the log returns is that it fluctuates dramatically around zero. Bitcoin shows high-frequency

volatility. The cryptocurrency's log return swings are higher compared to traditional stocks. The logarithm returns reveals that Bitcoin is a high-risk and high-volatility asset. It experiences large movements in a short time frame. The rolling volatility presents Bitcoin's volatility in a 30-day period. The repeated volatility spikes including the spikes from the 2017 bull run, 2020-2021 bull cycle, and the 2022 crypto crash are shown by the 30-day volatility. The spikes convey periods of uncertainty and rapid price swings. The moving average conveys an upward trend when it is above the 30-day moving average. When the price is below the 30-day moving average, it indicates a downward trend. The moving average dispels the noise and shows the long-term growth trend of Bitcoin. The moving average explains Bitcoin's major market cycles, which are long periods of growth followed by sharp corrections.

In conclusion, Bitcoin's price changes dramatically as it can increase or decrease rapidly. The first derivative confirms that Bitcoin is a very volatile asset. The second derivative indicates that the acceleration of the price movements can swing up and down, showing that trends can become stronger or weaker quickly. The logmarethic returns display the price percentage. Bitcoin has a higher rate of volatility in 30 days than other assets such as stocks. The 30-day moving average identifies longer trends despite the short-term noise. In summary, Bitcoin is an unpredictable asset in the short run, but it can convey a long period of time where the trend can be identified. Investors must assess risk if they want to make investment decisions for Bitcoin.

Works Cited

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