BTCVsFEDFUND

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1 In this document, we try to figure out the correlation between fed fund and bitcoin price. Many people believe fed fund is of cruicial importance for bitcoin price movement. Is that true?

[1]:
```
import yfinance as yf
import pandas as pd
import matplotlib.pyplot as plt
import  mplfinance as mpf
import numpy as np
```

1.1 This dataset contains 1674 months data of fed funds and is collected from https://alfred.stlouisfed.org/series/downloaddata?seid=FEDFUNDS:

[2]:
```
df = pd.read_csv("C:/users/alire/Downloads/FEDFUNDS.csv")
print("This dataaset contains", df.size, "months data of fed funds.")
df.head()
```

```
This dataaset contains 1674 months data of fed funds.
```

[2]:

	DATE	FEDFUNDS
0	1954-07-01	0.80
1	1954-08-01	1.22
2	1954-09-01	1.07
3	1954-10-01	0.85
4	1954-11-01	0.83

1.2 Good to know that there is no null value in dataset:

[3]:
```
df.isnull().sum()
```

[3]:
```
DATE        0
FEDFUNDS    0
dtype: int64
```

1.3 Let's take a look at description of dataset. As you see the mean of fed funds is equal to 4.6:

[4]:
```
df.describe()
```

[4]:
```
          FEDFUNDS
count  837.000000
mean     4.604277
std      3.586251
min      0.050000
25%      1.810000
50%      4.210000
75%      6.240000
max     19.100000
```

1.4 We can see which months had the highest rate of fed funds (if you're interested then you can do your own research to see what caused this at that time) :

[5]:
```
df.sort_values(by='FEDFUNDS', ascending = False).head()
```

[5]:
```
           DATE  FEDFUNDS
323  1981-06-01     19.10
318  1981-01-01     19.08
324  1981-07-01     19.04
317  1980-12-01     18.90
322  1981-05-01     18.52
```

1.5 And which had the lowest rate of fed funds:

[6]:
```
df.sort_values(by='FEDFUNDS', ascending = True).head()
```

[6]:
```
           DATE  FEDFUNDS
789  2020-04-01      0.05
790  2020-05-01      0.05
802  2021-05-01      0.06
715  2014-02-01      0.07
684  2011-07-01      0.07
```

1.6 Now we take a look at bitcoin dataset, it is collected with the help of yfinance library:

[7]:
```
btc_df = yf.download('BTC-USD', start='2020-01-01', end='2024-05-07')
btc_df.tail()
```

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

[7]:
```
                  Open          High           Low         Close  \
Date
2024-05-02  58253.703125  59602.296875  56937.203125  59123.433594
2024-05-03  59122.300781  63320.503906  58848.312500  62889.835938
2024-05-04  62891.031250  64494.957031  62599.351562  63891.472656
2024-05-05  63892.453125  64610.890625  62955.304688  64031.132812
2024-05-06  64038.312500  65494.902344  62746.238281  63161.949219

               Adj Close       Volume
Date
2024-05-02  59123.433594  32711813559
2024-05-03  62889.835938  33172023048
2024-05-04  63891.472656  20620477992
2024-05-05  64031.132812  18296164805
2024-05-06  63161.949219  28697928697
```

1.7 There is no null value in dataset:

[8]:
```
btc_df.isnull().sum()
```

[8]:
```
Open         0
High         0
Low          0
Close        0
Adj Close    0
Volume       0
dtype: int64
```

1.8 Let's take a look at description of dataset. The interesting thing to know is the mean of its price:

[9]:
```
btc_df.describe()
```

[9]:
```
                Open          High           Low         Close     Adj Close  \
count    1588.000000   1588.000000   1588.000000   1588.000000   1588.000000
mean    31096.145456  31803.978025  30338.623331  31128.740766  31128.740766
std     16648.659057  17076.687087  16150.514751  16653.867400  16653.867400
min      5002.578125   5331.833984   4106.980957   4970.788086   4970.788086
25%     18368.767090  18843.020508  17893.108887  18498.454102  18498.454102
50%     28965.372070  29364.446289  28422.126953  28969.038086  28969.038086
75%     42862.927734  43719.222656  42003.992188  42862.561523  42862.561523
max     73079.375000  73750.070312  71334.093750  73083.500000  73083.500000

              Volume
count   1.588000e+03
mean    3.225180e+10
std     1.854932e+10
```

```
min    5.331173e+09
25%    2.018018e+10
50%    2.920407e+10
75%    3.942206e+10
max    3.509679e+11
```

[10]:
```
btc_df["Close"].sort_values(ascending= False)
```

[10]:
```
Date
2024-03-13    73083.500000
2024-03-11    72123.906250
2024-04-08    71631.359375
2024-03-12    71481.289062
2024-03-14    71396.593750
                  …
2020-03-18     5238.438477
2020-03-17     5225.629395
2020-03-14     5200.366211
2020-03-16     5014.479980
2020-03-12     4970.788086
Name: Close, Length: 1588, dtype: float64
```

1.9 We will just consider the close price and ignore the shadows of candles :

[11]:
```
btc_df = pd.DataFrame(btc_df["Close"])
btc_df.head()
```

[11]:
```
                 Close
Date
2020-01-01  7200.174316
2020-01-02  6985.470215
2020-01-03  7344.884277
2020-01-04  7410.656738
2020-01-05  7411.317383
```

1.10 Since we have data of fed funds on first day of each month, we take the bitcoin price on first day of each month

[12]:
```
btc_df = btc_df.groupby(pd.Grouper(freq='MS')).first()
btc_df.head()
```

[12]:
```
                 Close
Date
2020-01-01  7200.174316
2020-02-01  9392.875000
2020-03-01  8562.454102
2020-04-01  6606.776367
```

```
2020-05-01  8864.766602
```

1.11 Let's normalize the price between 0 and 1

[13]:
```
min_btc_close = btc_df.min()
max_btc_close = btc_df.max()
btc_df = ((btc_df - min_btc_close) / (max_btc_close - min_btc_close)) * (1 - 0)
btc_df.head()
```

[13]:
```
                Close
Date
2020-01-01  0.009405
2020-02-01  0.044157
2020-03-01  0.030996
2020-04-01  0.000000
2020-05-01  0.035787
```

1.12 Let's normalize the data between 0 and 1

[14]:
```
df = df[-51:]
print("The size of dataset is :", df["FEDFUNDS"].size)
btc_df = btc_df[:-2]
print("The size of dataset is :" , btc_df["Close"].size)
```

```
The size of dataset is : 51
The size of dataset is : 51
```

[15]:
```
df.head(3)
```

[15]:
```
            DATE  FEDFUNDS
786  2020-01-01      1.55
787  2020-02-01      1.58
788  2020-03-01      0.65
```

[16]:
```
btc_df.head(3)
```

[16]:
```
                Close
Date
2020-01-01  0.009405
2020-02-01  0.044157
2020-03-01  0.030996
```

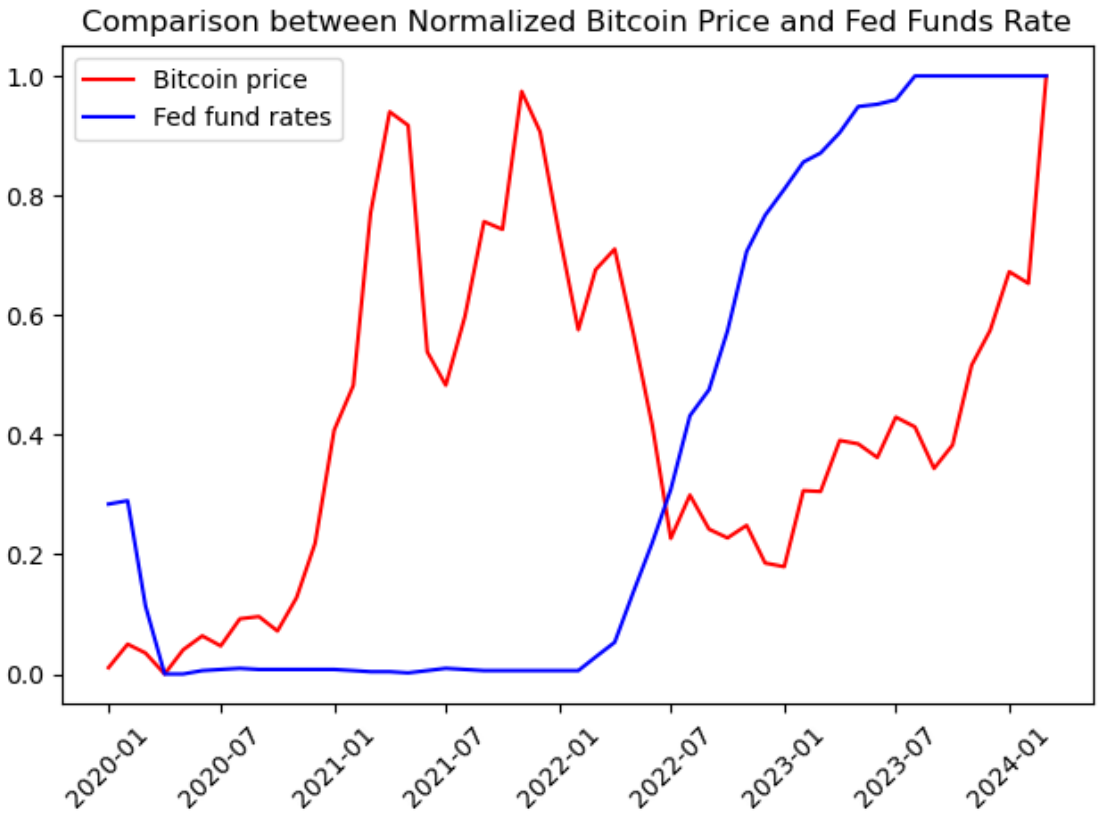
[17]:
```
min_fed_fund_rate = df["FEDFUNDS"].min()
max_fed_fund_rate = df["FEDFUNDS"].max()
df["FEDFUNDS"] = ((df["FEDFUNDS"]- min_fed_fund_rate ) / (max_fed_fund_rate-␣
 ↪min_fed_fund_rate)) * (1 - 0)
df.head()
```

[17]:
```
            DATE  FEDFUNDS
786  2020-01-01  0.284091
787  2020-02-01  0.289773
788  2020-03-01  0.113636
789  2020-04-01  0.000000
790  2020-05-01  0.000000
```

[18]:
```
min_btc_close_price = btc_df["Close"].min()
max_btc_close_price = btc_df["Close"].max()
btc_df["Close"] = ((btc_df["Close"] - min_btc_close_price ) /␣
 ↪(max_btc_close_price - min_btc_close_price)) * (1 - 0)
btc_df.head()
```

[18]:
```
               Close
Date
2020-01-01  0.010628
2020-02-01  0.049900
2020-03-01  0.035027
2020-04-01  0.000000
2020-05-01  0.040441
```

[19]:
```
plt.plot(btc_df.index, btc_df, color = "red", label= "Bitcoin price")
plt.plot(btc_df.index, df["FEDFUNDS"], color = "blue", label = "Fed fund rates")
plt.title("Comparison between Normalized Bitcoin Price and Fed Funds Rate")
plt.legend()
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



1.13 Let's calculate the pearson correlation which gives us a relatively good idea of how these two are related to each other:

[20]:
```
from scipy.stats import pearsonr
pearsonr_result = pearsonr(df["FEDFUNDS"],btc_df["Close"])
print(pearsonr_result[0])
if abs(pearsonr_result[0]) == 1:
    print("Perfect linear relationship")
elif abs(pearsonr_result[0]) >= 0.70:
    print("Strong relation")
elif 0.3 <= abs(pearsonr_result[0]) < 0.7 :
    print("A moderate relation")
elif abs(pearsonr_result[0]) < 0.3:
    print("Weak relation")
elif pearsonr_result[0] == 0:
    print("No correlation")
```

```
-0.020716781423593 67
Weak relation
```

1.14 So there is not a good correlation between them.

1.15 But what if we calculate that in shorted periods. Can they be related?

[21]:
```
i = 0
pearson_results = []
periods = []

while i <= 47:
    start_period = df.iloc[i]["DATE"]
    end_period = df.iloc[i+3]["DATE"]
    periods.append(f"Period {start_period} - {end_period}")

    pearson_result = (pearsonr(df["FEDFUNDS"][i:i+4], btc_df["Close"][i:
 ↪i+4]))[0]
    pearson_results.append(pearson_result)
    i += 3
```

```
C:\ProgramData\anaconda3\Lib\site-packages\scipy\stats\_stats_py.py:4781:
ConstantInputWarning: An input array is constant; the correlation coefficient is
not defined.
  warnings.warn(stats.ConstantInputWarning(msg))
```

[22]:
```
import math
i = 0
labeled_results = {}
for p_result in pearson_results:
    if abs(p_result) == 1:
        print("Perfect linear relationship in" , periods[i])
        labeled_results[periods[i]] = "Perfect"
    elif abs(p_result) >= 0.70:
        print("Strong relation in", periods[i])
        labeled_results[periods[i]] = "Strong"
    elif 0.3 <= abs(p_result) < 0.7 :
        print("A moderate relation in", periods[i])
        labeled_results[periods[i]] = "Moderate"
    elif abs(p_result) < 0.3:
        print("Weak relation in" , periods[i])
        labeled_results[periods[i]] = "Weak"
    elif p_result == 0:
        print("No correlation in ", periods[i])
        labeled_results[periods[i]] = "NoCorrelation"
    elif math.isnan(p_result):
        print("Fed fund was constant in" , periods[i], ", the correlation␣
 ↪coefficient is not defined.")
        labeled_results[periods[i]] = "Nan"
    i+=1
```

```
A moderate relation in Period 2020-01-01 - 2020-04-01
```

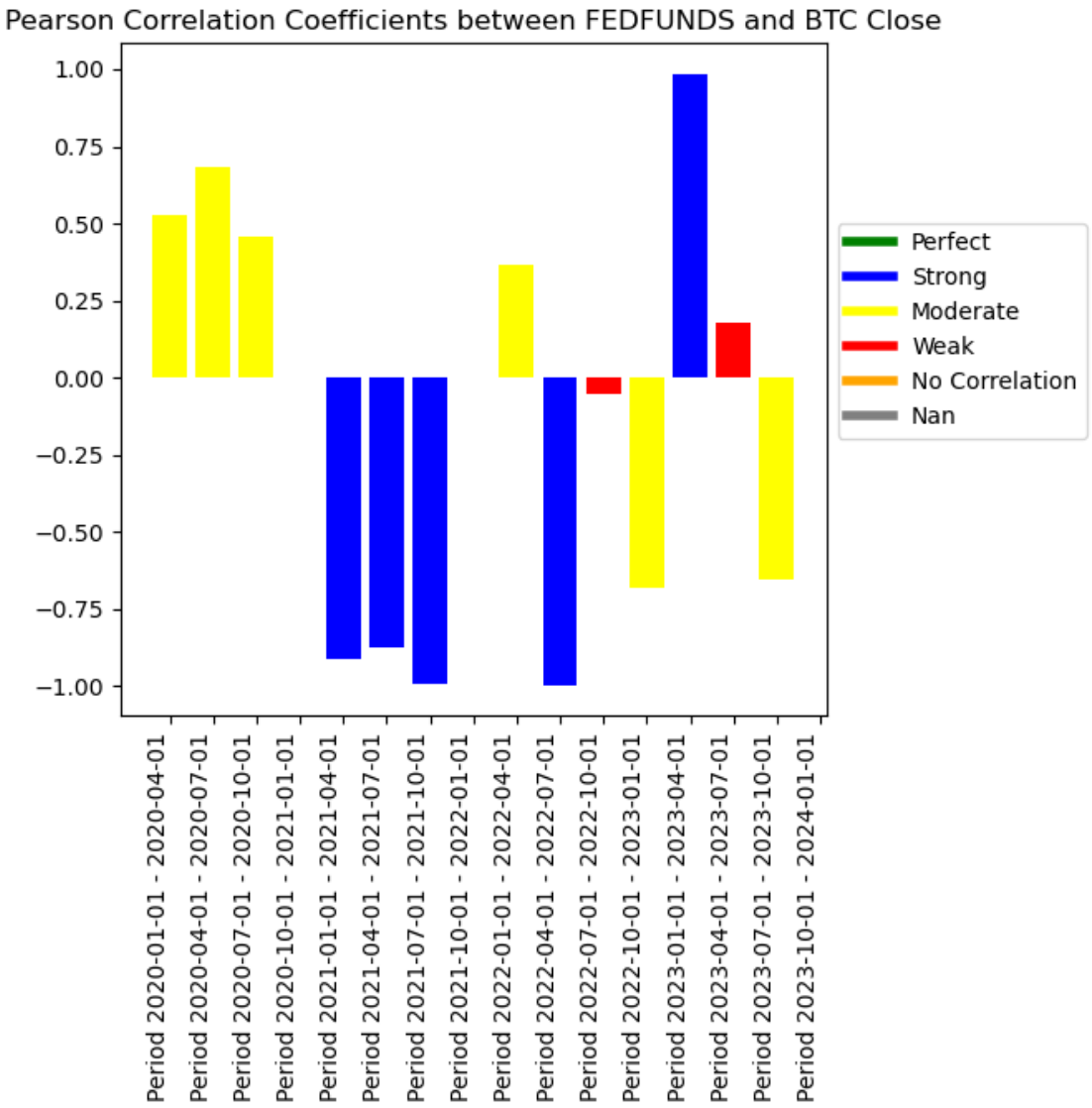
```
A moderate relation in Period 2020-04-01 - 2020-07-01
A moderate relation in Period 2020-07-01 - 2020-10-01
Fed fund was constant in Period 2020-10-01 - 2021-01-01 , the correlation
coefficient is not defined.
Strong relation in Period 2021-01-01 - 2021-04-01
Strong relation in Period 2021-04-01 - 2021-07-01
Strong relation in Period 2021-07-01 - 2021-10-01
Fed fund was constant in Period 2021-10-01 - 2022-01-01 , the correlation
coefficient is not defined.
A moderate relation in Period 2022-01-01 - 2022-04-01
Strong relation in Period 2022-04-01 - 2022-07-01
Weak relation in Period 2022-07-01 - 2022-10-01
A moderate relation in Period 2022-10-01 - 2023-01-01
Strong relation in Period 2023-01-01 - 2023-04-01
Weak relation in Period 2023-04-01 - 2023-07-01
A moderate relation in Period 2023-07-01 - 2023-10-01
Fed fund was constant in Period 2023-10-01 - 2024-01-01 , the correlation
coefficient is not defined.
```

1.16 We see improvements here. Even tough we got a weak relation before, there are some periods that shows us a strong relation. Let's visualize them to have a better understanding:

[32]:
```python
from matplotlib.lines import Line2D

colors = {
    "Perfect": "green",
    "Strong": "blue",
    "Moderate": "yellow",
    "Weak": "red",
    "NoCorrelation": "orange",
    "Nan": "gray"
}

bar_colors = []
for period in periods:
    if period in labeled_results:
        bar_color = colors[labeled_results.get(period)]
        bar_colors.append(bar_color)

x_values = np.arange(len(periods))

fig, ax = plt.subplots()
bars = ax.bar(periods, pearson_results, color=bar_colors)

plt.title('Pearson Correlation Coefficients between FEDFUNDS and BTC Close')
plt.tight_layout()
```

```
plt.xticks(x_values, periods, rotation=90, ha='right')

legend_elements = [
    Line2D([0], [0], color='green', lw=4, label='Perfect'),
    Line2D([0], [0], color='blue', lw=4, label='Strong'),
    Line2D([0], [0], color='yellow', lw=4, label='Moderate'),
    Line2D([0], [0], color='red', lw=4, label='Weak'),
    Line2D([0], [0], color='orange', lw=4, label='No Correlation'),
    Line2D([0], [0], color='gray', lw=4, label='Nan')
]
ax.legend(handles=legend_elements, loc='upper left', bbox_to_anchor=(1, 0.75))
```

[32]: <matplotlib.legend.Legend at 0x2ac7d7a2190>



[ ]: