```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import plotly.graph_objects as go
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
# Loading the CDS spread data for JP Morgan and Morgan Stanley from a CSV file
data = pd.read_csv("/content/drive/MyDrive/Combined_CDS_Spread_New.csv")
#JP is ourself
#MS is counterparty
```

```
print(data.head())
```

```
     Date  JPM_Spread  MS_Spread
0  14-Jan      0.7532     1.0148
1  14-Feb      0.6191     0.8766
2  14-Mar      0.5696     0.8717
3  14-Apr      0.5595     0.7380
4  14-May      0.5613     0.7224
```

```
# Renaming columns for clarity
data.rename(columns={'JPM_Spread':'JP', 'MS_Spread':'MS'},inplace=True)
print(data.head())
```

```
     Date      JP      MS
0  14-Jan  0.7532  1.0148
1  14-Feb  0.6191  0.8766
2  14-Mar  0.5696  0.8717
3  14-Apr  0.5595  0.7380
4  14-May  0.5613  0.7224
```

```
# Downsampling the data for analysis -Quater Wise
data = data.iloc[::3, :]
print(data.head())
```

```
      Date      JP      MS
0   14-Jan  0.7532  1.0148
3   14-Apr  0.5595  0.7380
6   14-Jul  0.6240  0.7577
9   14-Oct  0.5842  0.7875
12  15-Jan  0.7306  0.8275
```

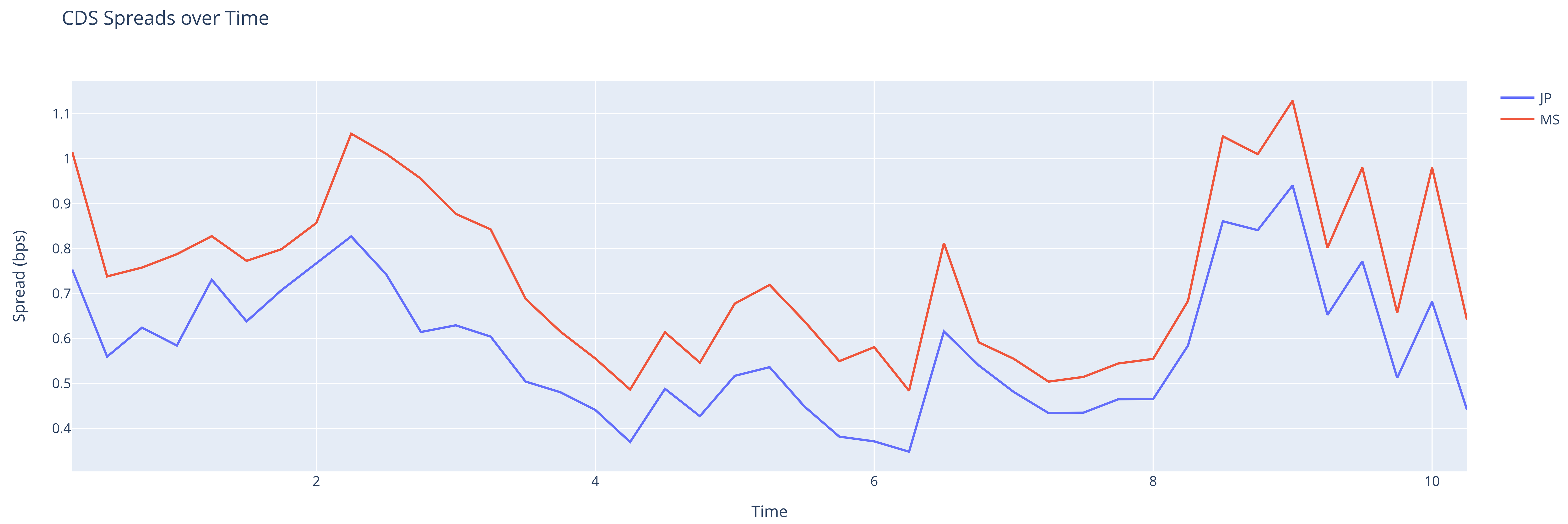
```
# Calculating hazard rates
data['JP_lambda']=data['JP']/(1-0.45)  #0.45 is our RR

# Calculating hazard rates
data['MS_lambda']=data['MS']/(1-0.60)  #0.60 is counterparty RR
print(data.head())
```

```
      Date      JP      MS  JP_lambda  MS_lambda
0   14-Jan  0.7532  1.0148   1.369455    2.53700
3   14-Apr  0.5595  0.7380   1.017273    1.84500
6   14-Jul  0.6240  0.7577   1.134545    1.89425
9   14-Oct  0.5842  0.7875   1.062182    1.96875
12  15-Jan  0.7306  0.8275   1.328364    2.06875
```

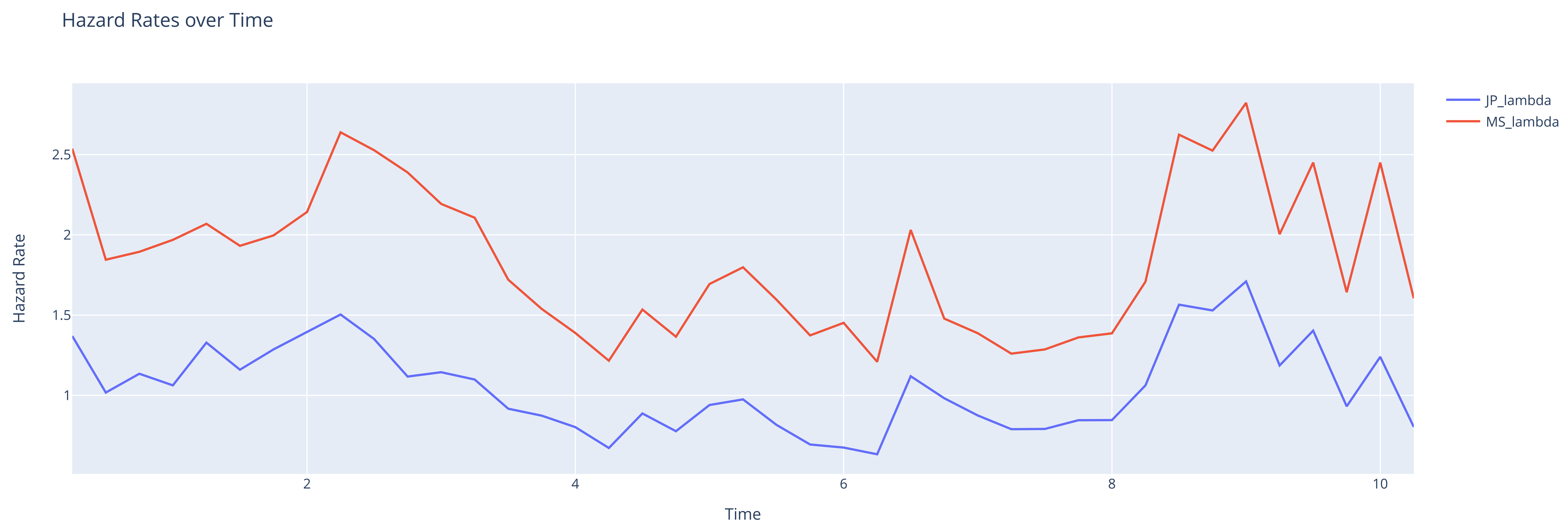
```
#Just to Make 0.25 , 0.5 -Time Steps
data['time']= ((data.index /3)+ 1  ) * 0.25
print(data.head())
```

```
      Date      JP      MS  JP_lambda  MS_lambda  time
0   14-Jan  0.7532  1.0148   1.369455    2.53700  0.25
3   14-Apr  0.5595  0.7380   1.017273    1.84500  0.50
6   14-Jul  0.6240  0.7577   1.134545    1.89425  0.75
9   14-Oct  0.5842  0.7875   1.062182    1.96875  1.00
12  15-Jan  0.7306  0.8275   1.328364    2.06875  1.25
```

```
# CDS Spread Visualization
fig = go.Figure()

# Add traces for 'JP' and 'MS' using the 'time' column as x-axis
fig.add_trace(go.Scatter(x=data['time'], y=data['JP'], mode='lines', name='JP'))
fig.add_trace(go.Scatter(x=data['time'], y=data['MS'], mode='lines', name='MS'))

fig.update_layout(
    title='CDS Spreads over Time',
    xaxis_title='Time',
    yaxis_title='Spread (bps)'
)

fig.show()
```




```
#Hazard Rate Plot
fig = go.Figure()


fig.add_trace(go.Scatter(x=data['time'], y=data['JP_lambda'], mode='lines', name='JP_lambda'))
fig.add_trace(go.Scatter(x=data['time'], y=data['MS_lambda'], mode='lines', name='MS_lambda'))

fig.update_layout(
    title='Hazard Rates over Time',
    xaxis_title='Time',
    yaxis_title='Hazard Rate'
)

fig.show()
```




```
#Marginal PD Calculation
#data['Difference'] = data['Value'] - data['Value'].shift(-1) e^lambda1*time1 - e^lambda2*time2 (0.25 and 0.5)
#shift brings the next value
data['JP_M_PD']=np.exp(-(data['JP_lambda']*data['time'])) -   np.exp(-(data['JP_lambda'].shift(-1)*data['time'].shift(-1)))
data['MS_M_PD']=np.exp(-(data['MS_lambda']*data['time'])) -   np.exp(-(data['MS_lambda'].shift(-1)*data['time'].shift(-1)))
print(data.head())
```

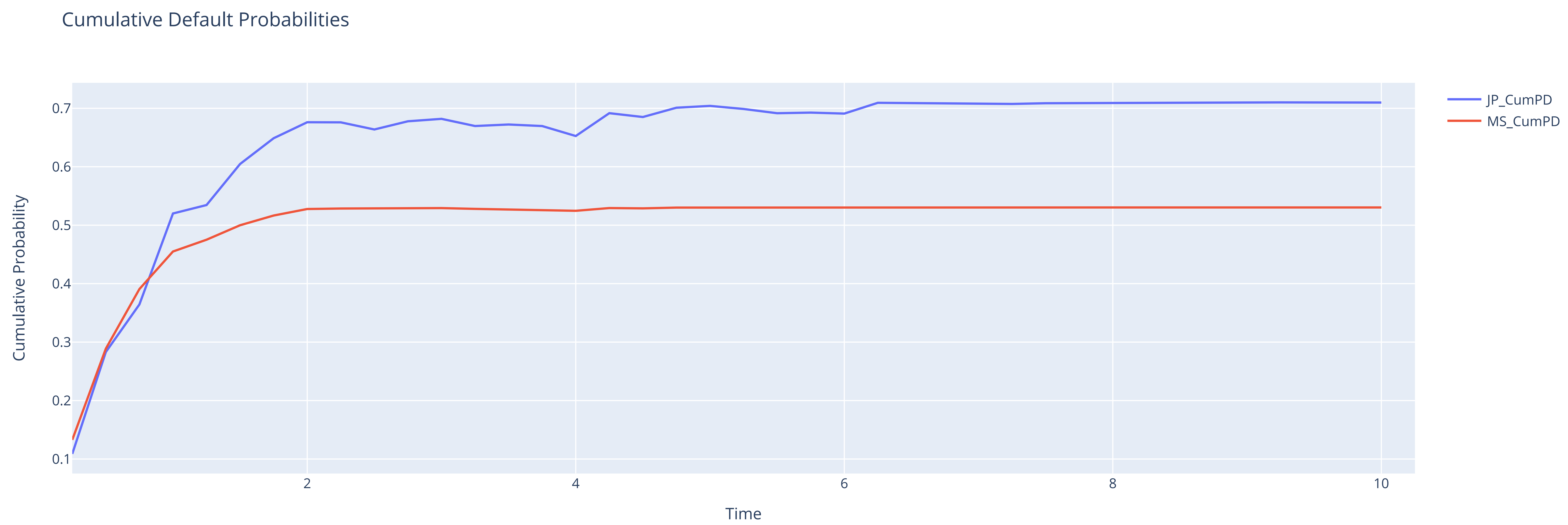
```
      Date      JP      MS  JP_lambda  MS_lambda  time   JP_M_PD   MS_M_PD  \
0   14-Jan  0.7532  1.0148   1.369455    2.53700  0.25  0.108775  0.132809
3   14-Apr  0.5595  0.7380   1.017273    1.84500  0.50  0.174288  0.155976
6   14-Jul  0.6240  0.7577   1.134545    1.89425  0.75  0.081326  0.101917
9   14-Oct  0.5842  0.7875   1.062182    1.96875  1.00  0.155648  0.064306
12  15-Jan  0.7306  0.8275   1.328364    2.06875  1.25  0.014436  0.020151

    JP_CumPD  MS_CumPD
0   0.108775  0.132809
3   0.283063  0.288785
6   0.364389  0.390702
9   0.520037  0.455008
12  0.534474  0.475158
```

```
# Calculating cumulative default probabilities
data['JP_CumPD']=data['JP_M_PD'].cumsum()

# Calculating cumulative default probabilities
data['MS_CumPD']=data['MS_M_PD'].cumsum()
print(data.head())
print(data.tail())
```

```
      Date      JP      MS  JP_lambda  MS_lambda  time   JP_M_PD   MS_M_PD  \
0   14-Jan  0.7532  1.0148   1.369455    2.53700  0.25  0.108775  0.132809
3   14-Apr  0.5595  0.7380   1.017273    1.84500  0.50  0.174288  0.155976
6   14-Jul  0.6240  0.7577   1.134545    1.89425  0.75  0.081326  0.101917
9   14-Oct  0.5842  0.7875   1.062182    1.96875  1.00  0.155648  0.064306
12  15-Jan  0.7306  0.8275   1.328364    2.06875  1.25  0.014436  0.020151

    JP_CumPD  MS_CumPD
0   0.108775  0.132809
3   0.283063  0.288785
6   0.364389  0.390702
9   0.520037  0.455008
12  0.534474  0.475158
       Date      JP      MS  JP_lambda  MS_lambda   time   JP_M_PD  \
108  23-Jan  0.6523  0.8015   1.186000    2.00375   9.25  0.000016
```

```
111  23-Apr  0.7717  0.9801   1.403091    2.45025   9.50 -0.000112
114  23-Jul  0.5122  0.6569   0.931273    1.64225   9.75  0.000110
117  23-Oct  0.6818  0.9801   1.239636    2.45025  10.00 -0.000262
120  24-Jan  0.4416  0.6417   0.802909    1.60425  10.25       NaN

          MS_M_PD  JP_CumPD  MS_CumPD
108  8.844758e-09  0.710088  0.530333
111 -1.111220e-07  0.709976  0.530333
114  1.111769e-07  0.710086  0.530333
117 -7.219617e-08  0.709823  0.530333
120           NaN       NaN       NaN
```

```
#Plot Cumulative Default Probabilities:
fig = go.Figure()


fig.add_trace(go.Scatter(x=data['time'], y=data['JP_CumPD'], mode='lines', name='JP_CumPD'))
fig.add_trace(go.Scatter(x=data['time'], y=data['MS_CumPD'], mode='lines', name='MS_CumPD'))

fig.update_layout(
    title='Cumulative Default Probabilities',
    xaxis_title='Time',
    yaxis_title='Cumulative Probability'
)


fig.show()
```




```
Our_CumPD=data['JP_CumPD'].iloc[-2]
CP_CumPD=data['MS_CumPD'].iloc[-2]
print(data['MS_CumPD'].iloc[-2]) #Counterparty's cumulative PD - For cVa
print(data['JP_CumPD'].iloc[-2]) #Our cumulative PD - For dVa
```

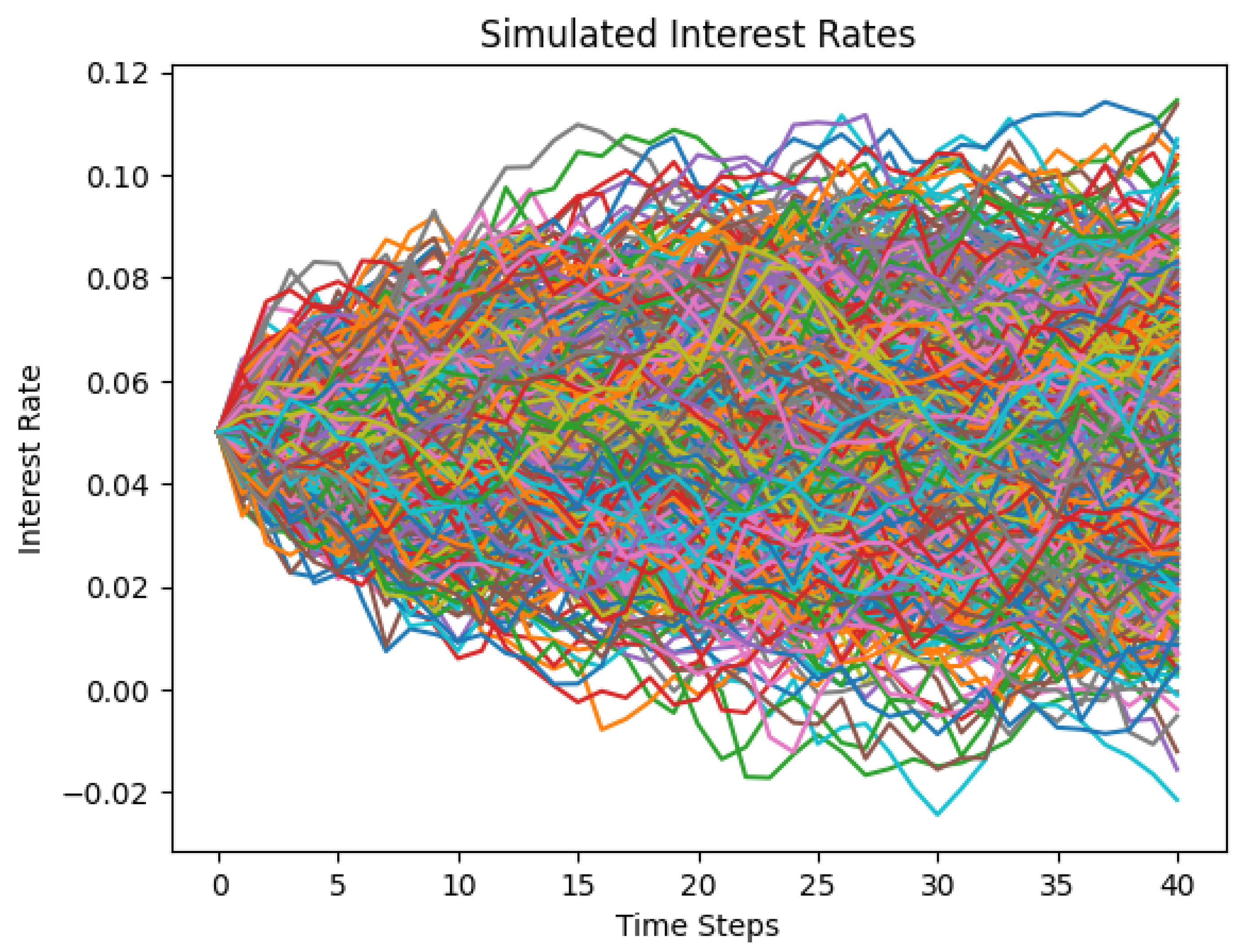
```
0.5303330167964186
0.70982335843477
```

```
#Simualting Values of IRS with Vaiscek Model

# Defining a function to simulate interest rates using the Vasicek model
def simulate_vasicek(a,b,sigma,r0,T,dt,n_paths):
  n_steps=int(T/dt)
  rates=np.zeros((n_steps+1,n_paths))
  rates[0]=r0
  for step in range(1,n_steps+1):
    dw=np.random.normal(0,np.sqrt(dt), n_paths)
    rates[step]=rates[step-1] + a * (b-rates[step-1]) * dt +sigma *dw

  return rates
```

```
# Define model parameters
a = 0.1  # Mean Reversion Rate
b = 0.05  # Long-Term Mean or Equilibrium Level
sigma = 0.01  # Volatility of Interest Rates
r0 = 0.05  # Initial Interest Rate
T = 10  # Time to Maturity
dt = 0.25  # Time Step
n_paths = 1000  # Number of Paths
```

```
# Simulate interest rates using the Vasicek model
simulated_rates = simulate_vasicek(a, b, sigma, r0, T, dt, n_paths)

# Compute discount factors using exponential functions
discount_factors = np.exp(-simulated_rates * np.arange(0, simulated_rates.shape[0])[:, None] * dt)

# Initialize simulation data dictionary
simulation_data = {'DF': []}

# Calculate average discount factors
simulation_data['DF'] = discount_factors.mean(axis=1)
```

```
#Vasicek model simulation

plt.plot(simulated_rates)
plt.title('Simulated Interest Rates')
plt.xlabel('Time Steps')
plt.ylabel('Interest Rate')
plt.show()
```

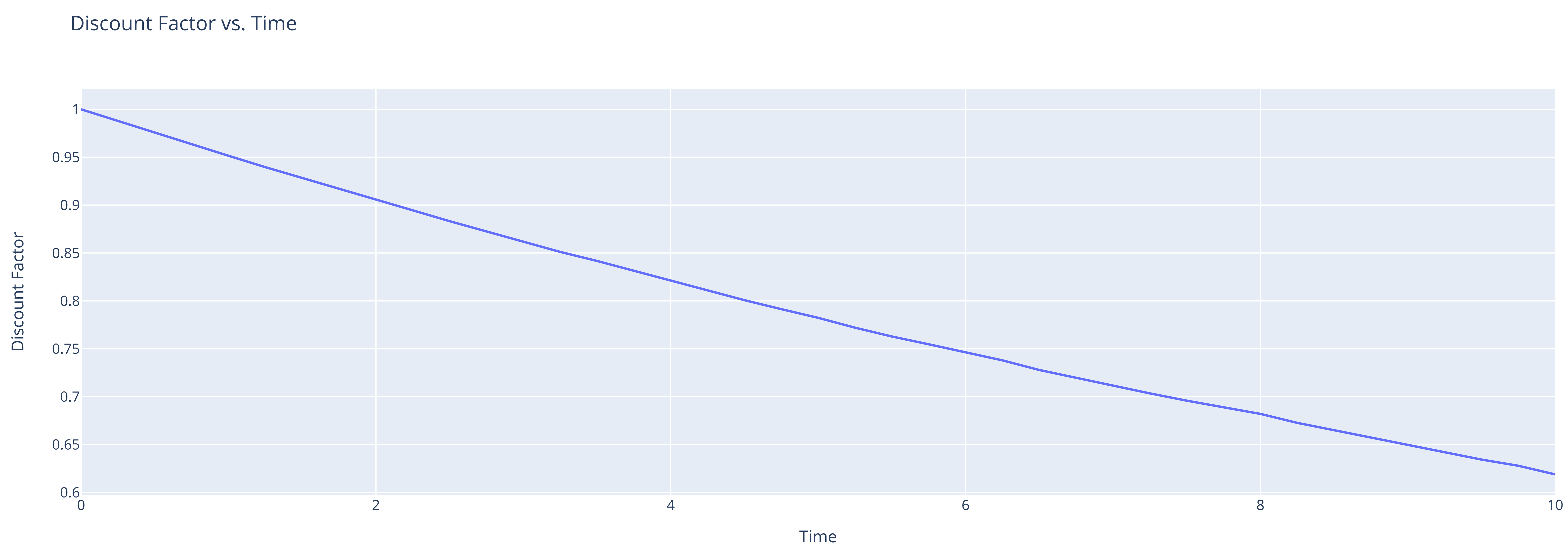



```
results_df=pd.DataFrame(simulation_data,index=np.arange(0,T+dt,dt))
```

```
print(results_df.head())
```

```
            DF
0.00  1.000000
0.25  0.987635
0.50  0.975333
0.75  0.963382
1.00  0.951484
```

```
fig = go.Figure()

# Iterate through the columns of 'results_df' to add traces
for column in results_df.columns:
    fig.add_trace(go.Scatter(x=results_df.index, y=results_df[column], mode='lines', name=column))

# Update the layout with labels and title
fig.update_layout(
    title='Discount Factor vs. Time',
    xaxis_title='Time',
    yaxis_title='Discount Factor'
)

# Show the plot
fig.show()
```




```
# Define contract parameters
notional = 1
fixed_rate = 0.055
payment_frequency = 1
```

```
# Initialize present value array
mtm_values = np.zeros_like(simulated_rates)
```

```
# Calculate MtM values
for step in range(1, mtm_values.shape[0]):
    time_to_maturity = T - step * dt

    # Calculate fixed leg present value
    fixed_leg_pv = notional * fixed_rate * np.exp(-simulated_rates[step] * time_to_maturity)

    # Calculate floating leg present value
    floating_leg_pv = notional * simulated_rates[step] * np.exp(-simulated_rates[step] * time_to_maturity)

    # Calculate MtM value for this step
    mtm_values[step] = fixed_leg_pv - floating_leg_pv
```

```
# Calculate expected exposure (EE)
EE = mtm_values

# Calculate average MtM across paths
average_MtM = mtm_values.mean(axis=1)
```

```
# Create a dictionary for simulation results
data1 = {'Time': np.arange(0, T + dt, dt),
         'Average MtM': average_MtM,
         'DF': simulation_data['DF']
         }

# Add individual run paths to the data dictionary
for path in range(n_paths):
    data1[f'Run {path + 1}'] = mtm_values[:, path]

# Create a DataFrame for the simulation results
results_df1 = pd.DataFrame(data1)
```

```
print(results_df1.head())
```

```
   Time  Average MtM        DF     Run 1     Run 2     Run 3     Run 4  \
0  0.00     0.000000  1.000000  0.000000  0.000000  0.000000  0.000000
1  0.25     0.003368  0.987635  0.003201  0.004301  0.000412  0.002318
2  0.50     0.003430  0.975333  0.001627 -0.001049 -0.002436 -0.003269
3  0.75     0.003738  0.963382  0.003414  0.000097 -0.001427 -0.001204
4  1.00     0.003873  0.951484  0.000003 -0.000184  0.002382  0.001688

      Run 5     Run 6     Run 7  ...   Run 991   Run 992   Run 993   Run 994  \
0  0.000000  0.000000  0.000000  ...  0.000000  0.000000  0.000000  0.000000
1  0.010854  0.006010 -0.000500  ...  0.003643  0.008477  0.003352  0.001584
2  0.007215  0.008497 -0.001454  ...  0.007351  0.012038  0.003287  0.005806
3  0.003210  0.006574  0.001986  ... -0.000440  0.007107  0.000785  0.007774
4  0.001420  0.004274  0.005198  ... -0.000596  0.007177 -0.000143  0.008140

    Run 995   Run 996   Run 997   Run 998   Run 999  Run 1000
0  0.000000  0.000000  0.000000  0.000000  0.000000  0.000000
1  0.003093  0.002481 -0.000078  0.008210  0.001179  0.002376
2  0.009864  0.009820  0.000013  0.004665  0.000684  0.004508
3  0.006935  0.007885  0.001127  0.009560  0.001059 -0.000828
4  0.006563  0.005982  0.000642  0.008680  0.000226  0.000613

[5 rows x 1003 columns]
```

```
fig = go.Figure()

# Add the main line for 'Time' vs. 'Average MtM'
fig.add_trace(go.Scatter(x=results_df1['Time'], y=results_df1['Average MtM'], mode='lines', name='Average MtM'))

# Select specific runs to add to the plot from 'Run 1' to 'Run 1000'
for run in range(1, 1001):
    fig.add_trace(go.Scatter(x=results_df1['Time'], y=results_df1[f'Run {run}'], mode='lines', name=f'Run {run}'))

# Add labels and a title
fig.update_layout(xaxis_title='Time', yaxis_title='Values', title='Values vs. Time')

# Show the plot
fig.show()
```


```
#Now the CVA Calculation

def create_dataframe():

    np.random.seed(987654321)
    # Generating a series of numbers from 1 to 1000
    numbers = pd.Series(range(1, 1001))

    # Generating a series of 1000 random numbers between 0 and 1
    random_numbers = pd.Series(np.random.rand(1000))

    # Creating a DataFrame with two columns
    df = pd.DataFrame({'Runs': numbers, 'Random_No': random_numbers})

    return df
```

```
# Create the DataFrame
df = create_dataframe()
df.head()
```

	Runs	Random_No
0	1	0.072988
1	2	0.216037
2	3	0.464753
3	4	0.622590
4	5	0.618388

```
#Adding Default Indicator
df['Default_indicator'] = (df['Random_No'] < CP_CumPD).astype(int)
df.head()
```

	Runs	Random_No	Default_indicator
0	1	0.072988	1
1	2	0.216037	1
2	3	0.464753	1
3	4	0.622590	0
4	5	0.618388	0

```
data_df = pd.DataFrame(data)
```

```
# Function to find the corresponding time for each default
def find_time_for_default(row):
    # Find the last time where MS_CumPD is less than or equal to the random number
    filtered_data = data_df[data_df['MS_CumPD'] <= row['Random_No']]
    if not filtered_data.empty:
        return filtered_data.iloc[-1]['time']
    else:
        return None  # or some default value

# Apply the function using .loc to rows in df where Default_indicator is 1
df.loc[df['Default_indicator'] == 1, 'time of default'] = df[df['Default_indicator'] == 1].apply(find_time_for_default, axis=1)

print(df.head())
```

```
   Runs  Random_No  Default_indicator  time of default
0     1   0.072988                  1              NaN
1     2   0.216037                  1             0.25
2     3   0.464753                  1             1.00
3     4   0.622590                  0              NaN
4     5   0.618388                  0              NaN
```

```
# Apply the function using .loc to rows in df where Default_indicator is 1
df.loc[df['Default_indicator'] == 1, 'time of default'] = df[df['Default_indicator'] == 1].apply(find_time_for_default, axis=1)

# Set 'time of default' to 0 where it is NaN and 'Default_indicator' is 1
df.loc[(df['Default_indicator'] == 1) & (df['time of default'].isna()), 'time of default'] = 0

print(df.head())
```

```
   Runs  Random_No  Default_indicator  time of default
0     1   0.072988                  1             0.00
1     2   0.216037                  1             0.25
2     3   0.464753                  1             1.00
3     4   0.622590                  0              NaN
4     5   0.618388                  0              NaN
```

```
# Ensure the data types are compatible
df['time of default'] = df['time of default'].astype(results_df1['Time'].dtype)
```

```
# Perform a left merge
merged_df = df.merge(
    results_df1[['Time', 'DF']],
    left_on='time of default',
    right_on='Time',
    how='left'
)
```

```
# Rename the 'DF' column to 'DF1' and drop the extra 'Time' column from the merge
merged_df.rename(columns={'DF': 'DF1'}, inplace=True)
merged_df.drop(columns=['Time'], inplace=True)

# 'merged_df' now contains the original data from 'df' with the additional 'DF1' column

print(merged_df.head())
```

```
   Runs  Random_No  Default_indicator  time of default       DF1
0     1   0.072988                  1             0.00  1.000000
1     2   0.216037                  1             0.25  0.987635
2     3   0.464753                  1             1.00  0.951484
3     4   0.622590                  0              NaN       NaN
4     5   0.618388                  0              NaN       NaN
```

```
def get_value(row):
    run_col = 'Run ' + str(int(row['Runs']))  # Ensure the run number is an integer

    if run_col in results_df1.columns:
        matching_row = results_df1[results_df1['Time'] == row['time of default']]

        # # Debugging: Print statements to check the process
        if matching_row.empty:
          pass

        #    # print(f"No matching time step for Run {row['Runs']} at time {row['time of default']}")
        else:
            #     #print(f"Match found for Run {row['Runs']} at time {row['time of default']}: {matching_row[run_col].iloc[0]}")
          return matching_row[run_col].iloc[0]



    else:
      pass
        #print(f"Run column {run_col} not found")
    return None

# Apply the function to each row in merged_df
merged_df['value'] = merged_df.apply(get_value, axis=1)
merged_df.head()
```

	Runs	Random_No	Default_indicator	time of default	DF1	value
0	1	0.072988	1	0.00	1.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301
2	3	0.464753	1	1.00	0.951484	0.002382
3	4	0.622590	0	NaN	NaN	NaN
4	5	0.618388	0	NaN	NaN	NaN

```
#Stats
positive_count = (merged_df['value'] > 0).sum()
negative_count = (merged_df['value'] < 0).sum()
nan_count = merged_df['value'].isna().sum()
print(positive_count,negative_count,nan_count)
```

```
311 71 489
```

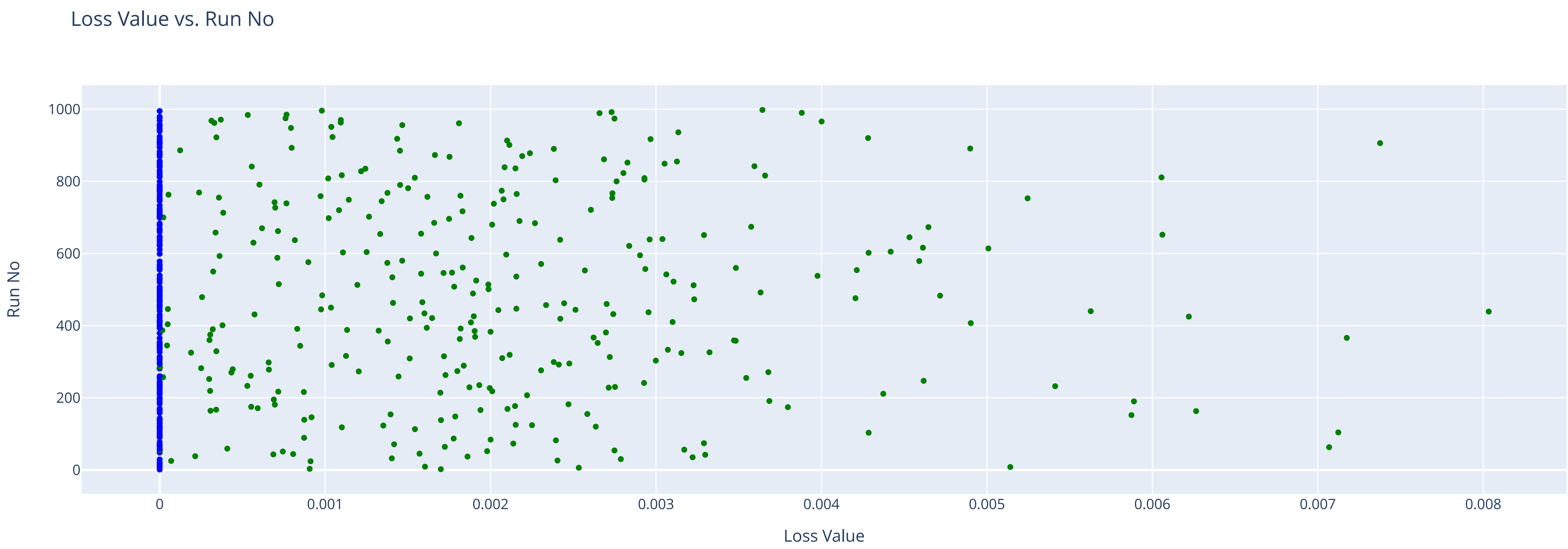
```
#Consider only Positive Exposures
merged_df['Exposure'] = merged_df['value'].apply(lambda x: max(0, x) if pd.notna(x) else 0)  #Positive Exposure Only
merged_df.head()
```

	Runs	Random_No	Default_indicator	time of default	DF1	value	Exposure
0	1	0.072988	1	0.00	1.000000	0.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301	0.004301
2	3	0.464753	1	1.00	0.951484	0.002382	0.002382
3	4	0.622590	0	NaN	NaN	NaN	0.000000
4	5	0.618388	0	NaN	NaN	NaN	0.000000

```
#Final Loss Values
CP_LGD=1-0.60 # Assuming a recovery rate of 60% for MS
merged_df['Loss']=merged_df['DF1']*merged_df['Exposure']*CP_LGD
merged_df.head(10)
```

	Runs	Random_No	Default_indicator	time of default	DF1	value	Exposure	Loss
0	1	0.072988	1	0.00	1.000000	0.000000	0.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301	0.004301	0.001699
2	3	0.464753	1	1.00	0.951484	0.002382	0.002382	0.000907
3	4	0.622590	0	NaN	NaN	NaN	0.000000	NaN
4	5	0.618388	0	NaN	NaN	NaN	0.000000	NaN
5	6	0.427379	1	0.75	0.963382	0.006574	0.006574	0.002533
6	7	0.111334	1	0.00	1.000000	0.000000	0.000000	0.000000
7	8	0.526045	1	4.00	0.820450	0.015666	0.015666	0.005141
8	9	0.269190	1	0.25	0.987635	0.004060	0.004060	0.001604
9	10	0.640339	0	NaN	NaN	NaN	0.000000	NaN

```
df321 = merged_df[['Runs', 'Loss']]  # Select the 'Runs' and 'Loss' columns

# Define a color array based on the 'Loss' values
colors = ['blue' if loss == 0 else 'green' for loss in df321['Loss']]

# Create a scatter plot with reversed axes and conditional coloring
fig = go.Figure(data=go.Scatter(x=df321['Loss'], y=df321['Runs'], mode='markers', marker=dict(color=colors)))

fig.update_traces(marker=dict(size=5))  # Adjust marker size
fig.update_layout(title='Loss Value vs. Run No')
fig.update_xaxes(title_text='Loss Value')  # X-axis label
fig.update_yaxes(title_text='Run No')       # Y-axis label

# Show the plot
fig.show()
```




```
CVA=merged_df['Loss'].mean() *1000000  #1 million notional principal
print("CVA=",CVA)
```

```
CVA= 1267.5962565868372
```

```
#Now we will calculate DVA

# Create the DataFrame
df1 = create_dataframe()
df1.head()
```

	Runs	Random_No
0	1	0.072988
1	2	0.216037
2	3	0.464753
3	4	0.622590
4	5	0.618388

```
df1['Default_indicator'] = (df1['Random_No'] < Our_CumPD).astype(int)
df1.head()
```

	Runs	Random_No	Default_indicator
0	1	0.072988	1
1	2	0.216037	1
2	3	0.464753	1
3	4	0.622590	1
4	5	0.618388	1

```
def find_time_for_default(row):
    # Find the last time where MS_CumPD is less than or equal to the random number
    filtered_data = data_df[data_df['MS_CumPD'] <= row['Random_No']]
    if not filtered_data.empty:
        return filtered_data.iloc[-1]['time']
    else:
        return None  # or some default value
```

```
# Apply the function using .loc to rows in df where Default_indicator is 1
df1.loc[df1['Default_indicator'] == 1, 'time of default'] = df1[df1['Default_indicator'] == 1].apply(find_time_for_default, axis=1)

df1.head()
```

	Runs	Random_No	Default_indicator	time of default
0	1	0.072988	1	NaN
1	2	0.216037	1	0.25
2	3	0.464753	1	1.00
3	4	0.622590	1	10.00
4	5	0.618388	1	10.00

```
# Apply the function using .loc to rows in df where Default_indicator is 1
df1.loc[df1['Default_indicator'] == 1, 'time of default'] = df1[df1['Default_indicator'] == 1].apply(find_time_for_default, axis=1)

# Set 'time of default' to 0 where it is NaN and 'Default_indicator' is 1
df1.loc[(df1['Default_indicator'] == 1) & (df1['time of default'].isna()), 'time of default'] = 0

df1.head(10)
```

	Runs	Random_No	Default_indicator	time of default
0	1	0.072988	1	0.00
1	2	0.216037	1	0.25
2	3	0.464753	1	1.00
3	4	0.622590	1	10.00
4	5	0.618388	1	10.00
5	6	0.427379	1	0.75
6	7	0.111334	1	0.00
7	8	0.526045	1	4.00
8	9	0.269190	1	0.25
9	10	0.640339	1	10.00

```
# Ensure the data types are compatible
df1['time of default'] = df1['time of default'].astype(results_df1['Time'].dtype)

# Perform a left merge
merged_df1 = df1.merge(
    results_df1[['Time', 'DF']],
    left_on='time of default',
    right_on='Time',
    how='left'
)
```

```
# Rename the 'DF' column to 'DF1' and drop the extra 'Time' column from the merge
merged_df1.rename(columns={'DF': 'DF1'}, inplace=True)
merged_df1.drop(columns=['Time'], inplace=True)
```

```
# 'merged_df1' now contains the original data from 'df' with the additional 'DF1' column

merged_df1['value'] = merged_df1.apply(get_value, axis=1)
merged_df1.head(10)
```

	Runs	Random_No	Default_indicator	time of default	DF1	value
0	1	0.072988	1	0.00	1.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301
2	3	0.464753	1	1.00	0.951484	0.002382
3	4	0.622590	1	10.00	0.618833	-0.041663
4	5	0.618388	1	10.00	0.618833	0.026033
5	6	0.427379	1	0.75	0.963382	0.006574
6	7	0.111334	1	0.00	1.000000	0.000000
7	8	0.526045	1	4.00	0.820450	0.015666
8	9	0.269190	1	0.25	0.987635	0.004060
9	10	0.640339	1	10.00	0.618833	-0.015970

```
#Stats
positive_count = (merged_df1['value'] > 0).sum()
negative_count = (merged_df1['value'] < 0).sum()
nan_count = merged_df1['value'].isna().sum()
print(positive_count,negative_count,nan_count)
```

```
437 161 273
```

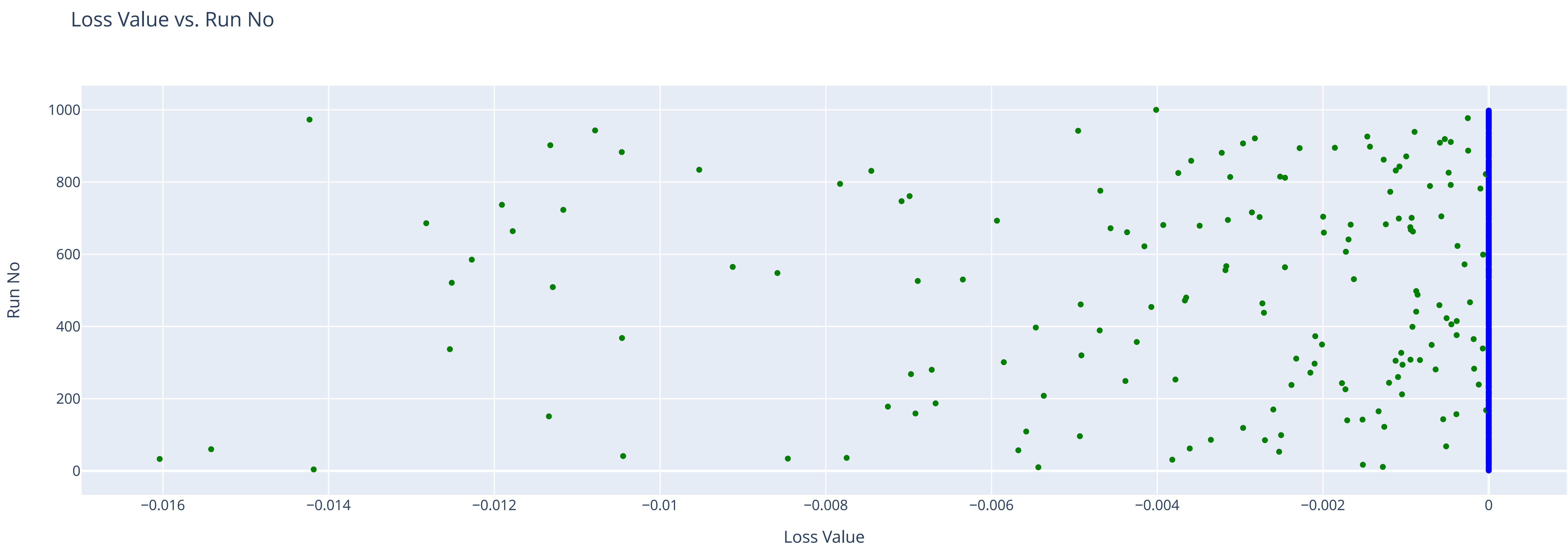
```
merged_df1['Exposure'] = merged_df1['value'].apply(lambda x: x if x < 0 else 0)  #Negative Exposure only
merged_df1.head(10)
```

	Runs	Random_No	Default_indicator	time of default	DF1	value	Exposure
0	1	0.072988	1	0.00	1.000000	0.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301	0.000000
2	3	0.464753	1	1.00	0.951484	0.002382	0.000000
3	4	0.622590	1	10.00	0.618833	-0.041663	-0.041663
4	5	0.618388	1	10.00	0.618833	0.026033	0.000000
5	6	0.427379	1	0.75	0.963382	0.006574	0.000000
6	7	0.111334	1	0.00	1.000000	0.000000	0.000000
7	8	0.526045	1	4.00	0.820450	0.015666	0.000000
8	9	0.269190	1	0.25	0.987635	0.004060	0.000000
9	10	0.640339	1	10.00	0.618833	-0.015970	-0.015970

```
Our_LGD=1-0.45 #JP
merged_df1['Loss']=merged_df1['DF1']*merged_df1['Exposure']*Our_LGD
merged_df1.head(10)
```

	Runs	Random_No	Default_indicator	time of default	DF1	value	Exposure	Loss
0	1	0.072988	1	0.00	1.000000	0.000000	0.000000	0.000000
1	2	0.216037	1	0.25	0.987635	0.004301	0.000000	0.000000
2	3	0.464753	1	1.00	0.951484	0.002382	0.000000	0.000000
3	4	0.622590	1	10.00	0.618833	-0.041663	-0.041663	-0.014180
4	5	0.618388	1	10.00	0.618833	0.026033	0.000000	0.000000
5	6	0.427379	1	0.75	0.963382	0.006574	0.000000	0.000000
6	7	0.111334	1	0.00	1.000000	0.000000	0.000000	0.000000
7	8	0.526045	1	4.00	0.820450	0.015666	0.000000	0.000000
8	9	0.269190	1	0.25	0.987635	0.004060	0.000000	0.000000
9	10	0.640339	1	10.00	0.618833	-0.015970	-0.015970	-0.005435

```
df3210 = merged_df1[['Runs', 'Loss']]  # Select the 'Runs' and 'Loss' columns

# Define a color array based on the 'Loss' values
colors = ['blue' if loss == 0 else 'green' for loss in df3210['Loss']]

# Create a scatter plot with reversed axes and conditional coloring
fig = go.Figure(data=go.Scatter(x=df3210['Loss'], y=df3210['Runs'], mode='markers', marker=dict(color=colors)))

fig.update_traces(marker=dict(size=5))  # Adjust marker size
fig.update_layout(title='Loss Value vs. Run No')
fig.update_xaxes(title_text='Loss Value')  # X-axis label
fig.update_yaxes(title_text='Run No')       # Y-axis label

# Show the plot
fig.show()
```




```
DVA=merged_df1['Loss'].mean() *1000000  #1 million notional principal
print("DVA=",DVA)
```

```
DVA= -836.7706148216657
```

```
print(merged_df1)
```

```
     Runs  Random_No  Default_indicator  time of default       DF1     value  \
0       1   0.072988                  1             0.00  1.000000  0.000000
1       2   0.216037                  1             0.25  0.987635  0.004301
2       3   0.464753                  1             1.00  0.951484  0.002382
3       4   0.622590                  1            10.00  0.618833 -0.041663
4       5   0.618388                  1            10.00  0.618833  0.026033
..    ...        ...                ...              ...       ...       ...
995   996   0.206384                  1             0.25  0.987635  0.002481
996   997   0.900697                  0              NaN       NaN       NaN
997   998   0.493368                  1             1.25  0.939594  0.009694
998   999   0.858213                  0              NaN       NaN       NaN
999  1000   0.684922                  1            10.00  0.618833 -0.011792

     Exposure      Loss
0    0.000000  0.000000
1    0.000000  0.000000
2    0.000000  0.000000
3   -0.041663 -0.014180
4    0.000000  0.000000
..        ...       ...
995  0.000000  0.000000
996  0.000000       NaN
997  0.000000  0.000000
998  0.000000       NaN
999 -0.011792 -0.004014

[1000 rows x 8 columns]
```

```
print(merged_df1)
```

```
     Runs  Random_No  Default_indicator  time of default       DF1     value  \
0       1   0.072988                  1             0.00  1.000000  0.000000
1       2   0.216037                  1             0.25  0.987635  0.004301
2       3   0.464753                  1             1.00  0.951484  0.002382
3       4   0.622590                  1            10.00  0.618833 -0.041663
4       5   0.618388                  1            10.00  0.618833  0.026033
..    ...        ...                ...              ...       ...       ...
995   996   0.206384                  1             0.25  0.987635  0.002481
996   997   0.900697                  0              NaN       NaN       NaN
997   998   0.493368                  1             1.25  0.939594  0.009694
998   999   0.858213                  0              NaN       NaN       NaN
999  1000   0.684922                  1            10.00  0.618833 -0.011792

     Exposure      Loss
0    0.000000  0.000000
1    0.000000  0.000000
2    0.000000  0.000000
3   -0.041663 -0.014180
4    0.000000  0.000000
..        ...       ...
995  0.000000  0.000000
996  0.000000       NaN
997  0.000000  0.000000
998  0.000000       NaN
999 -0.011792 -0.004014

[1000 rows x 8 columns]
```

```
print(merged_df1)
```

```
     Runs  Random_No  Default_indicator  time of default       DF1     value  \
0       1   0.072988                  1             0.00  1.000000  0.000000
1       2   0.216037                  1             0.25  0.987635  0.004301
2       3   0.464753                  1             1.00  0.951484  0.002382
3       4   0.622590                  1            10.00  0.618833 -0.041663
4       5   0.618388                  1            10.00  0.618833  0.026033
```

```
..   ...       ...              ...          ...       ...       ...
995   996  0.206384               1          0.25  0.987635  0.002481
996   997  0.900697               0           NaN       NaN       NaN
997   998  0.493368               1          1.25  0.939594  0.009694
998   999  0.858213               0           NaN       NaN       NaN
999  1000  0.684922               1         10.00  0.618833 -0.011792

   Exposure      Loss
0  0.000000  0.000000
1  0.000000  0.000000
2  0.000000  0.000000
```