In [2]:
```
import pandas as pd
import yfinance as yf
import matplotlib.pyplot as plt
import numpy as np
#return_2018 = pd.read_csv('strategy_return_2018.csv')
```

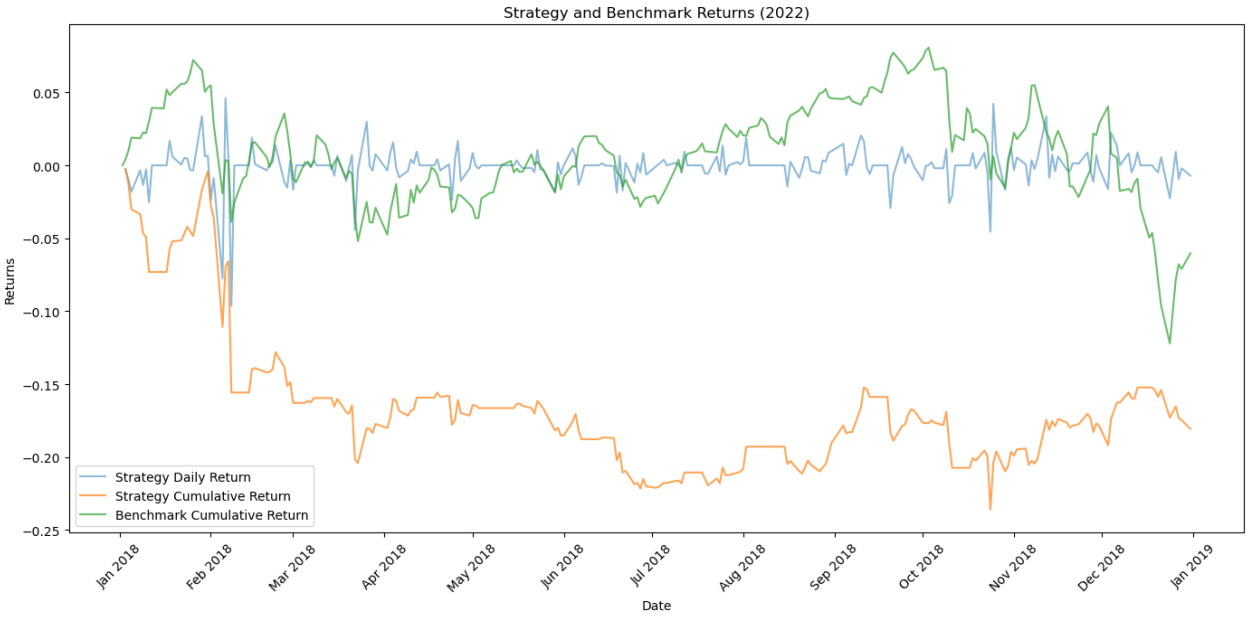
2018

In [10]:
```
# Return, Cumulative Return and benchmark
```

In [108…
```
dow_jones = yf.Ticker("^DJI").history(start='2018-01-01', end='2019-01-01
benchmark_2018 = pd.DataFrame(dow_jones['Close'].pct_change().rename('Ben

# Convert the index of benchmark_returns to a 'Date' column, ensuring it'
benchmark_2018.reset_index(inplace=True)
benchmark_2018['Date'] = pd.to_datetime(benchmark_2018['Date']).dt.strfti

# Ensure the 'Date' column in strategy_return_df is in string format and
return_2018['Date'] = pd.to_datetime(return_2018['Date']).dt.strftime('%Y

# Make sure both Date columns are of the same data type, preferably strin
return_2018['Date'] = return_2018['Date'].astype(str)
benchmark_2022['Date'] = benchmark_2018['Date'].astype(str)
combined_returns_2018 = pd.merge(return_2018, benchmark_2018, on='Date',
```

In [111…
```
# Filling missing values in 'Benchmark_Returns' with 0 for plotting purpo
combined_returns_2018['Benchmark_Returns'].fillna(0, inplace=True)

# Calculate cumulative returns
combined_returns_2018['Strategy_Cumulative_Return'] = (1 + combined_retur
combined_returns_2018['Benchmark_Cumulative_Return'] = (1 + combined_retu

# Converting 'Date' to datetime format for better axis management
combined_returns_2018['Date'] = pd.to_datetime(combined_returns_2018['Dat

plt.figure(figsize=(14, 7))

# Strategy Daily Return
plt.plot(combined_returns_2018['Date'], combined_returns_2018['0'], label

# Strategy Cumulative Return
plt.plot(combined_returns_2018['Date'], combined_returns_2018['Strategy_C

# Benchmark Cumulative Return
plt.plot(combined_returns_2018['Date'], combined_returns_2018['Benchmark_

plt.xlabel('Date')
plt.ylabel('Returns')
plt.title('Strategy and Benchmark Returns (2022)')
```

```
# Improving the x-axis appearance
plt.gca().xaxis.set_major_locator(mdates.MonthLocator())
plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%b %Y'))
plt.xticks(rotation=45)

plt.legend()
plt.tight_layout()
plt.show()
```



In [120…

```
# Rolling Vol & Sharpe
```

Out[120…

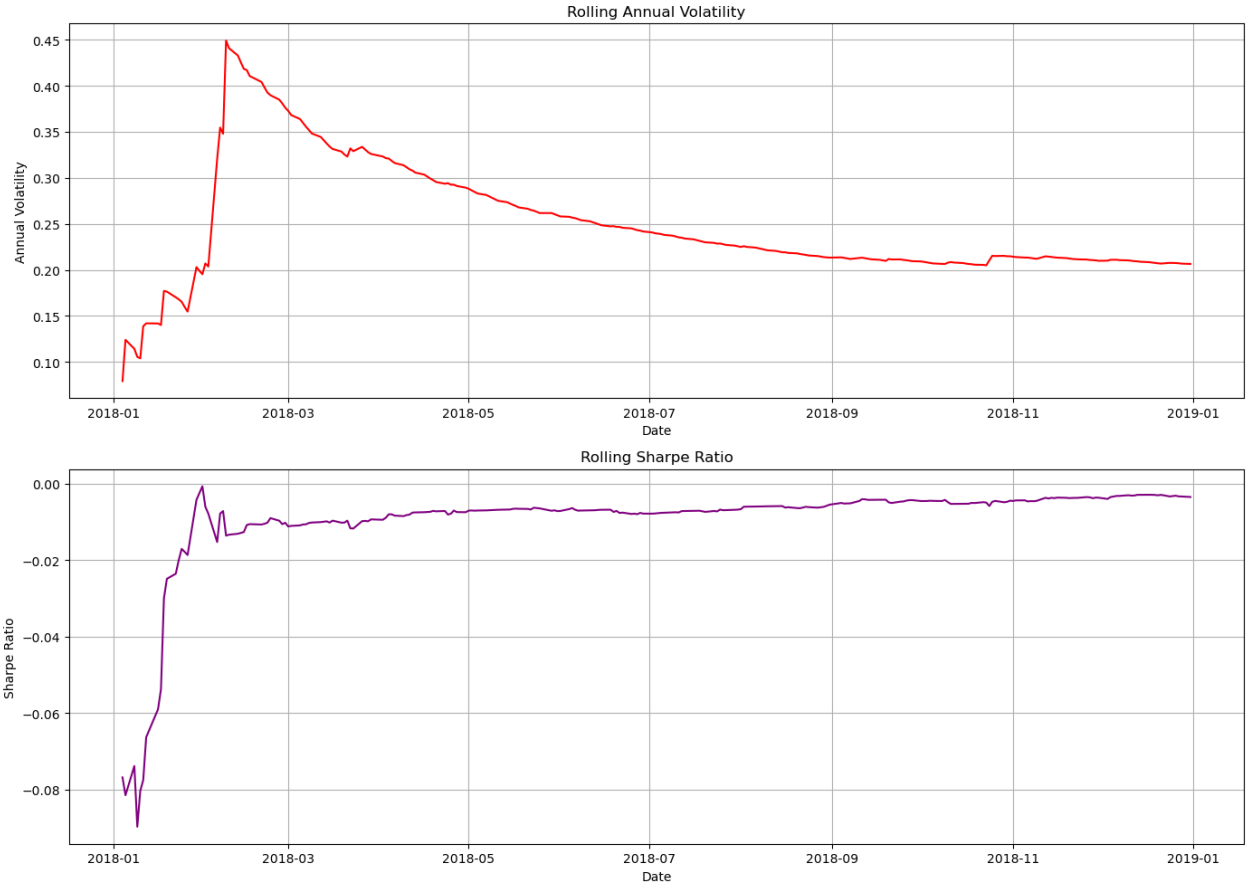
	Date	0	Benchmark_Returns	Strategy_Cumulative_Return	Benchma
0	2018-01-02	NaN	0.000000	NaN	
1	2018-01-03	-0.002556	0.003975	-0.002556	
2	2018-01-04	-0.009605	0.006117	-0.012136	
3	2018-01-05	-0.018149	0.008803	-0.030065	
4	2018-01-08	-0.003434	-0.000509	-0.033396	
...	...	...	...	...	
246	2018-12-24	-0.022554	-0.029100	-0.173014	
247	2018-12-26	0.009281	0.049846	-0.165339	
248	2018-12-27	-0.009406	0.011381	-0.173190	
249	2018-12-28	-0.001957	-0.003303	-0.174807	
250	2018-12-31	-0.007091	0.011493	-0.180659	

251 rows × 5 columns

In [121…

```
# Calculate rolling annual volatility and Sharpe ratio for the strategy
daily_returns = combined_returns_2018['0']  # Strategy daily returns
rolling_annual_volatility = daily_returns.rolling(window=252, min_periods
rolling_sharpe_ratio = daily_returns.rolling(window=252, min_periods=min_

# Plotting
fig, ax = plt.subplots(2, 1, figsize=(14, 10))

# Rolling Annual Volatility
ax[0].plot(combined_returns_2018['Date'], rolling_annual_volatility, labe
ax[0].set_title('Rolling Annual Volatility')
ax[0].set_xlabel('Date')
ax[0].set_ylabel('Annual Volatility')
ax[0].grid(True)

# Rolling Sharpe Ratio
```

```
ax[1].plot(combined_returns_2018['Date'], rolling_sharpe_ratio, label='Sh
ax[1].set_title('Rolling Sharpe Ratio')
ax[1].set_xlabel('Date')
ax[1].set_ylabel('Sharpe Ratio')
ax[1].grid(True)

plt.tight_layout()
plt.show()
```



In [134…

Out[134…

	Date	0	Benchmark_Returns	Strategy_Cumulative_Return	Benchma
0	2018-01-02	NaN	0.000000	NaN	
1	2018-01-03	-0.002556	0.003975	-0.002556	
2	2018-01-04	-0.009605	0.006117	-0.012136	
3	2018-01-05	-0.018149	0.008803	-0.030065	
4	2018-01-08	-0.003434	-0.000509	-0.033396	
…	…	…	…	…	
246	2018-12-24	-0.022554	-0.029100	-0.173014	
247	2018-12-26	0.009281	0.049846	-0.165339	
248	2018-12-27	-0.009406	0.011381	-0.173190	
249	2018-12-28	-0.001957	-0.003303	-0.174807	
250	2018-12-31	-0.007091	0.011493	-0.180659	

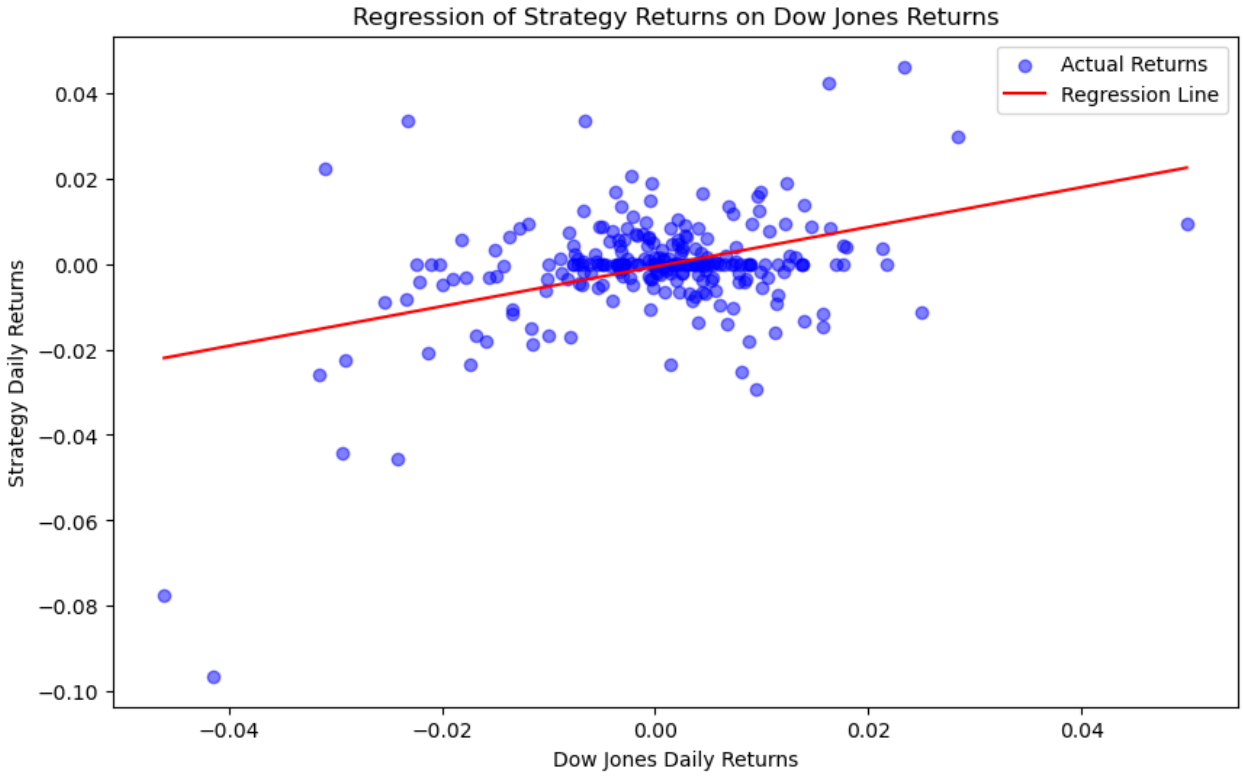
251 rows × 5 columns

In [135…

```
X = combined_returns_2018[['Benchmark_Returns']]  # Independent variable
y = combined_returns_2018['0'].fillna(0).values  # Dependent variable (St

# Fit the linear regression model
model = LinearRegression().fit(X, y)

# Generate a sequence of Dow Jones returns spanning the observed range to
X_fit = np.linspace(X.min(), X.max(), 100).reshape(-1, 1)
y_fit = model.predict(X_fit)
strategy_beta = model.coef_[0]

# Plotting
plt.figure(figsize=(10, 6))
plt.scatter(X, y, color='blue', label='Actual Returns', alpha=0.5)  # Plo
plt.plot(X_fit, y_fit, color='red', label='Regression Line')  # Plot the
plt.xlabel('Dow Jones Daily Returns')
```

```
plt.ylabel('Strategy Daily Returns')
plt.title('Regression of Strategy Returns on Dow Jones Returns')
plt.legend()
plt.show()
```

```
/Users/hanks/anaconda3/lib/python3.11/site-packages/sklearn/base.py:464: U
serWarning: X does not have valid feature names, but LinearRegression was
fitted with feature names
  warnings.warn(
```



In [136…
```
strategy_beta
```

Out[136…
```
0.46417863907304
```

In [139…
```
# Calculate annual return of the strategy
annual_return_strategy = (1 + combined_returns_2018['0'].fillna(0)).prod(

# Calculate mean daily return of the Dow Jones and then its annualized me
mean_daily_return_dow_jones = combined_returns_2018['Benchmark_Returns'].
annual_return_dow_jones = mean_daily_return_dow_jones * 252

# Calculate strategy alpha using the provided formula
strategy_alpha = annual_return_strategy - (strategy_beta * annual_return_

annual_return_strategy, annual_return_dow_jones, strategy_alpha
```

Out[139…
```
(-0.3373942052040262, -0.046403042836854626, -0.31585490393116705)
```

2020

In [51]:
```
# Load strategy return data
strategy_return_df = pd.read_csv('strategy_return_marchtojuly_2020.csv')
print(strategy_return_df.head())
```

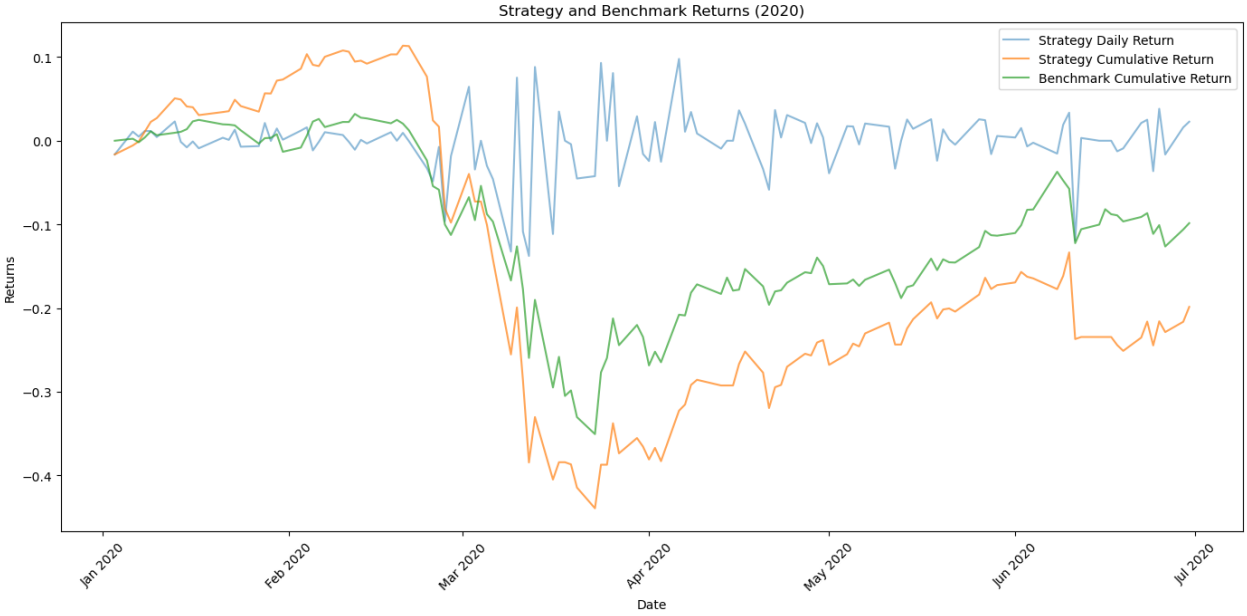
```
         Date         0
0  2020-01-02       NaN
1  2020-01-03 -0.016376
2  2020-01-06  0.010865
3  2020-01-07  0.004926
4  2020-01-08  0.011634
```

In [75]:
```
dow_jones = yf.Ticker("DJI")
benchmark_returns = pd.DataFrame(dow_jones.history(start='2020-01-01', en

# Convert the index of benchmark_returns to a 'Date' column, ensuring it'
benchmark_returns.reset_index(inplace=True)
benchmark_returns['Date'] = pd.to_datetime(benchmark_returns['Date']).dt.

# Ensure the 'Date' column in strategy_return_df is in string format and
strategy_return_df['Date'] = pd.to_datetime(strategy_return_df['Date']).d

# Make sure both Date columns are of the same data type, preferably strin
strategy_return_df['Date'] = strategy_return_df['Date'].astype(str)
benchmark_returns['Date'] = benchmark_returns['Date'].astype(str)
combined_returns = pd.merge(strategy_return_df, benchmark_returns, on='Da
```

In [78]:
```
combined_returns.to_csv('combined_returns.csv', index=False)
```

In [84]:
```
import matplotlib.dates as mdates

# Filling missing values in 'Benchmark_Returns' with 0 for plotting purpo
combined_returns['Benchmark_Returns'].fillna(0, inplace=True)

# Calculate cumulative returns
combined_returns['Strategy_Cumulative_Return'] = (1 + combined_returns['0
combined_returns['Benchmark_Cumulative_Return'] = (1 + combined_returns['

# Converting 'Date' to datetime format for better axis management
combined_returns['Date'] = pd.to_datetime(combined_returns['Date'])

plt.figure(figsize=(14, 7))

# Strategy Daily Return
plt.plot(combined_returns['Date'], combined_returns['0'], label='Strategy

# Strategy Cumulative Return
plt.plot(combined_returns['Date'], combined_returns['Strategy_Cumulative_

# Benchmark Cumulative Return
plt.plot(combined_returns['Date'], combined_returns['Benchmark_Cumulative

plt.xlabel('Date')
plt.ylabel('Returns')
```

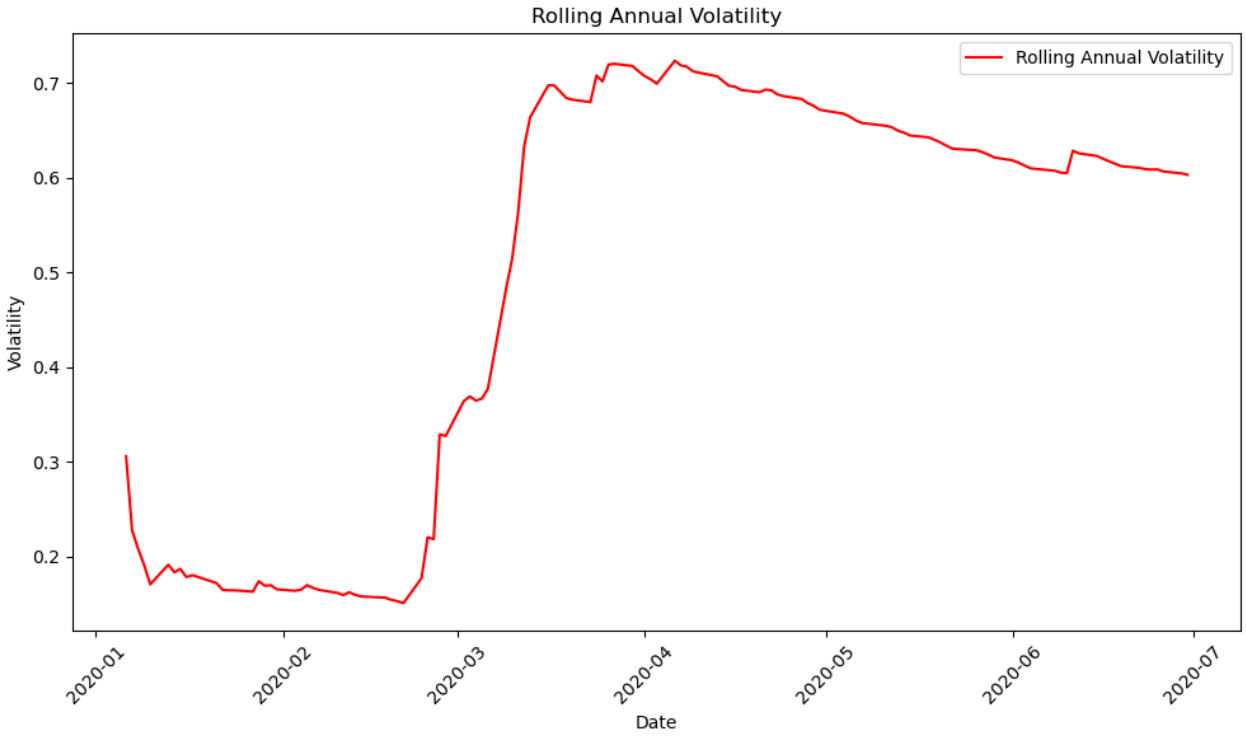
```
plt.title('Strategy and Benchmark Returns (2020)')

# Improving the x-axis appearance
plt.gca().xaxis.set_major_locator(mdates.MonthLocator())
plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%b %Y'))
plt.xticks(rotation=45)

plt.legend()
plt.tight_layout()
plt.show()
```

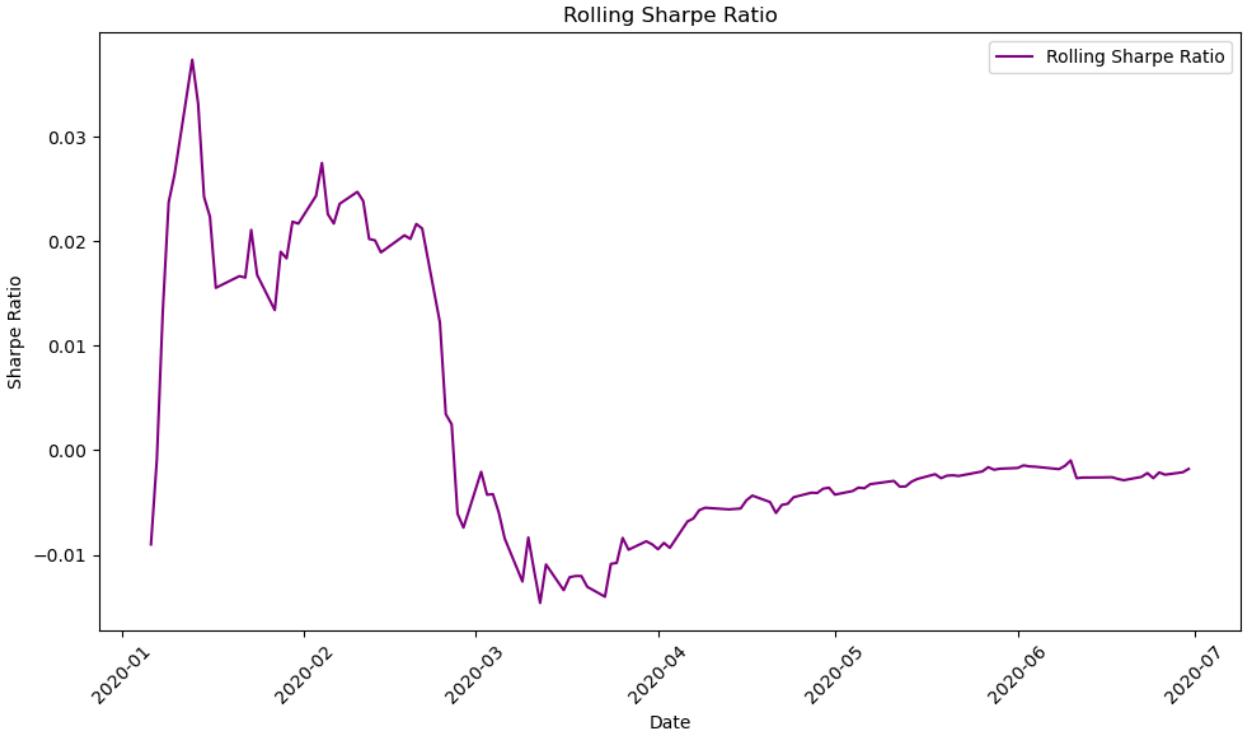


In [124…

```
import numpy as np
# Calculate rolling annual volatility and Sharpe ratio for the strategy
daily_returns = combined_returns['0']  # Strategy daily returns

# Calculate rolling annual volatility
rolling_annual_volatility = combined_returns['0'].rolling(window=252, min

# Calculate rolling Sharpe Ratio
rolling_sharpe_ratio = combined_returns['0'].rolling(window=252, min_peri

# Plotting Rolling Annual Volatility
plt.figure(figsize=(10, 6))
plt.plot(combined_returns['Date'], rolling_annual_volatility, label='Roll
plt.title('Rolling Annual Volatility')
plt.xlabel('Date')
plt.ylabel('Volatility')
plt.legend()
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()

# Plotting Rolling Sharpe Ratio
plt.figure(figsize=(10, 6))
plt.plot(combined_returns['Date'], rolling_sharpe_ratio, label='Rolling S
plt.title('Rolling Sharpe Ratio')
```

```
plt.xlabel('Date')
plt.ylabel('Sharpe Ratio')
plt.legend()
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



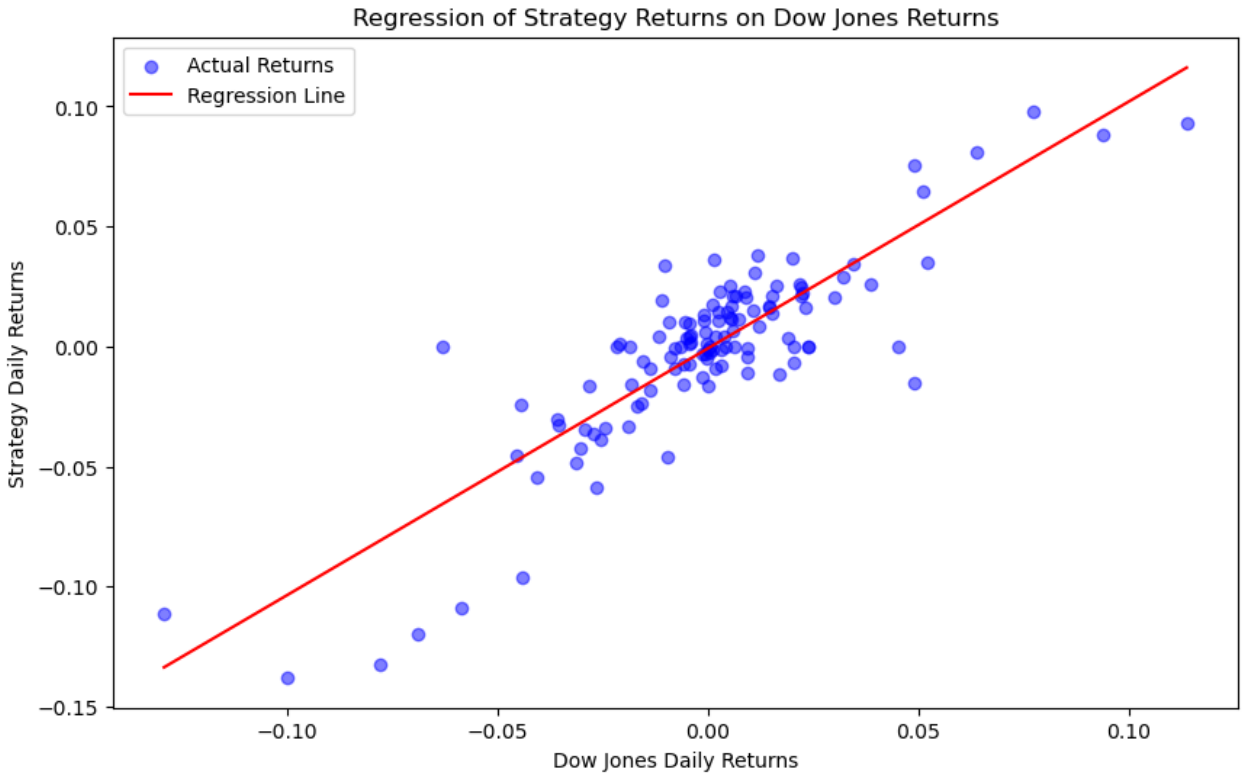


In [128…

```
# The slope of the regression line (beta) represents the strategy's portf
strategy_beta = model.coef_[0]

from sklearn.linear_model import LinearRegression
```

```
X = combined_returns[['Benchmark_Returns']]  # Independent variable (Dow
y = combined_returns['0']  # Dependent variable (Strategy returns)

# Fit the linear regression model
model = LinearRegression().fit(X, y)

# Generate a sequence of Dow Jones returns spanning the observed range to
X_fit = np.linspace(X.min(), X.max(), 100).reshape(-1, 1)
y_fit = model.predict(X_fit)

# Plotting
plt.figure(figsize=(10, 6))
plt.scatter(X, y, color='blue', label='Actual Returns', alpha=0.5)  # Plo
plt.plot(X_fit, y_fit, color='red', label='Regression Line')  # Plot the
plt.xlabel('Dow Jones Daily Returns')
plt.ylabel('Strategy Daily Returns')
plt.title('Regression of Strategy Returns on Dow Jones Returns')
plt.legend()
plt.show()
```

```
/Users/hanks/anaconda3/lib/python3.11/site-packages/sklearn/base.py:464: U
serWarning: X does not have valid feature names, but LinearRegression was
fitted with feature names
  warnings.warn(
```



In [126…
```
strategy_beta
```

Out[126…
```
1.028138348149412
```

In [137…
```
# Calculate annual return of the strategy
```

```
annual_return_strategy = (1 + combined_returns['0'].fillna(0)).prod() **

# Calculate mean daily return of the Dow Jones and then its annualized me
mean_daily_return_dow_jones = combined_returns['Benchmark_Returns'].filln
annual_return_dow_jones = mean_daily_return_dow_jones * 252

# Calculate strategy alpha using the provided formula
strategy_alpha = annual_return_strategy - (strategy_beta * annual_return_

annual_return_strategy, annual_return_dow_jones, strategy_alpha
```

Out[137… (-0.3670646879016496, -0.08707810945745931, -0.3266448895606329)

2022

In [3]:
```
return_2022 = pd.read_csv('~/Downloads/strategy_return_2022to2023.csv')
return_2022.head()
```

Out[3]:

	Date	0
0	2022-02-28	NaN
1	2022-03-01	0.006131
2	2022-03-02	-0.001207
3	2022-03-03	0.009365
4	2022-03-04	0.000000

In [4]:
```
dow_jones = yf.Ticker("^DJI").history(start='2022-03-01', end='2023-02-27
benchmark_2022 = pd.DataFrame(dow_jones['Close'].pct_change().rename('Ben

# Convert the index of benchmark_returns to a 'Date' column, ensuring it'
benchmark_2022.reset_index(inplace=True)
benchmark_2022['Date'] = pd.to_datetime(benchmark_2022['Date']).dt.strfti

# Ensure the 'Date' column in strategy_return_df is in string format and
return_2022['Date'] = pd.to_datetime(return_2022['Date']).dt.strftime('%Y

# Make sure both Date columns are of the same data type, preferably strin
return_2022['Date'] = return_2022['Date'].astype(str)
benchmark_2022['Date'] = benchmark_2022['Date'].astype(str)
combined_returns_2022 = pd.merge(return_2022, benchmark_2022, on='Date',
```

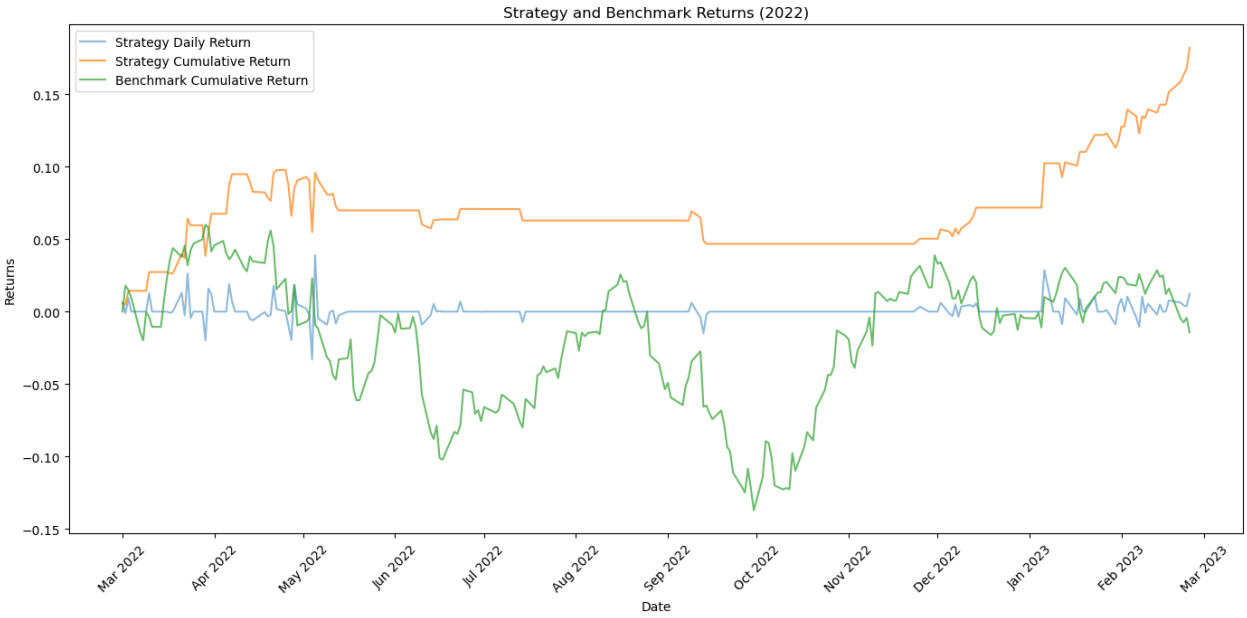
```
/Users/yiyujie/anaconda3/lib/python3.11/site-packages/yfinance/utils.py:77
5: FutureWarning: The 'unit' keyword in TimedeltaIndex construction is dep
recated and will be removed in a future version. Use pd.to_timedelta inste
ad.
  df.index += _pd.TimedeltaIndex(dst_error_hours, 'h')
```

In [29]:
```
combined_returns_2022['Strategy_Cumulative_Return']
```

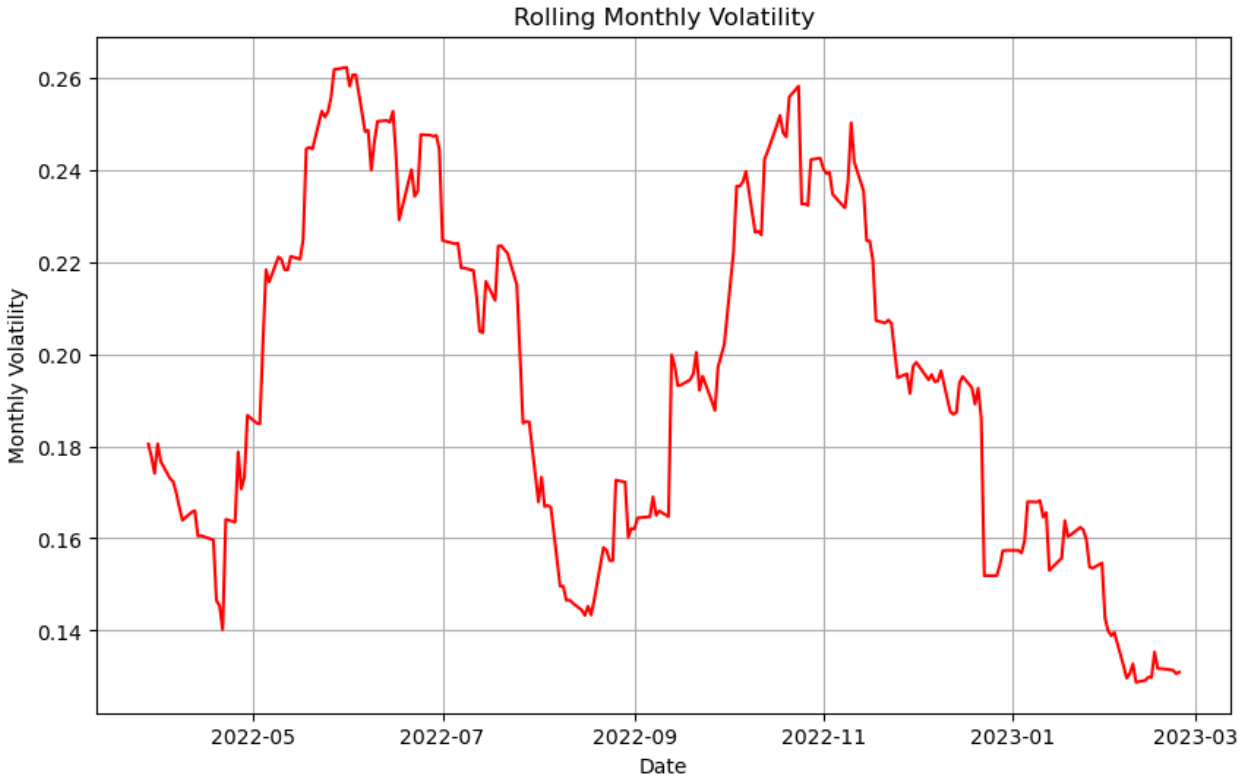
Out[29]:
```
0      0.006131
1      0.004917
2      0.014328
3      0.014328
4      0.014328
         ...
244    0.151649
245    0.158803
246    0.163711
247    0.167932
248    0.182266
Name: Strategy_Cumulative_Return, Length: 249, dtype: float64
```

In [6]:
```
# Filling missing values in 'Benchmark_Returns' with 0 for plotting purpo
combined_returns_2022['Benchmark_Returns'].fillna(0, inplace=True)

# Calculate cumulative returns
combined_returns_2022['Strategy_Cumulative_Return'] = (1 + combined_retur
combined_returns_2022['Benchmark_Cumulative_Return'] = (1 + combined_retu

# Converting 'Date' to datetime format for better axis management
combined_returns_2022['Date'] = pd.to_datetime(combined_returns_2022['Dat

plt.figure(figsize=(14, 7))

# Strategy Daily Return
plt.plot(combined_returns_2022['Date'], combined_returns_2022['0'], label

# Strategy Cumulative Return
plt.plot(combined_returns_2022['Date'], combined_returns_2022['Strategy_C

# Benchmark Cumulative Return
plt.plot(combined_returns_2022['Date'], combined_returns_2022['Benchmark_

plt.xlabel('Date')
plt.ylabel('Returns')
plt.title('Strategy and Benchmark Returns (2022)')

# Improving the x-axis appearance
import matplotlib.dates as mdates
plt.gca().xaxis.set_major_locator(mdates.MonthLocator())
plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%b %Y'))
plt.xticks(rotation=45)

plt.legend()
plt.tight_layout()
plt.show()
```

```
/var/folders/l_/m6g3497s5j77bqb9jr7506tc0000gn/T/ipykernel_35961/366487959.py:2: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value) instead, to perform the operation inplace on the original object.


  combined_returns_2022['Benchmark_Returns'].fillna(0, inplace=True)
```

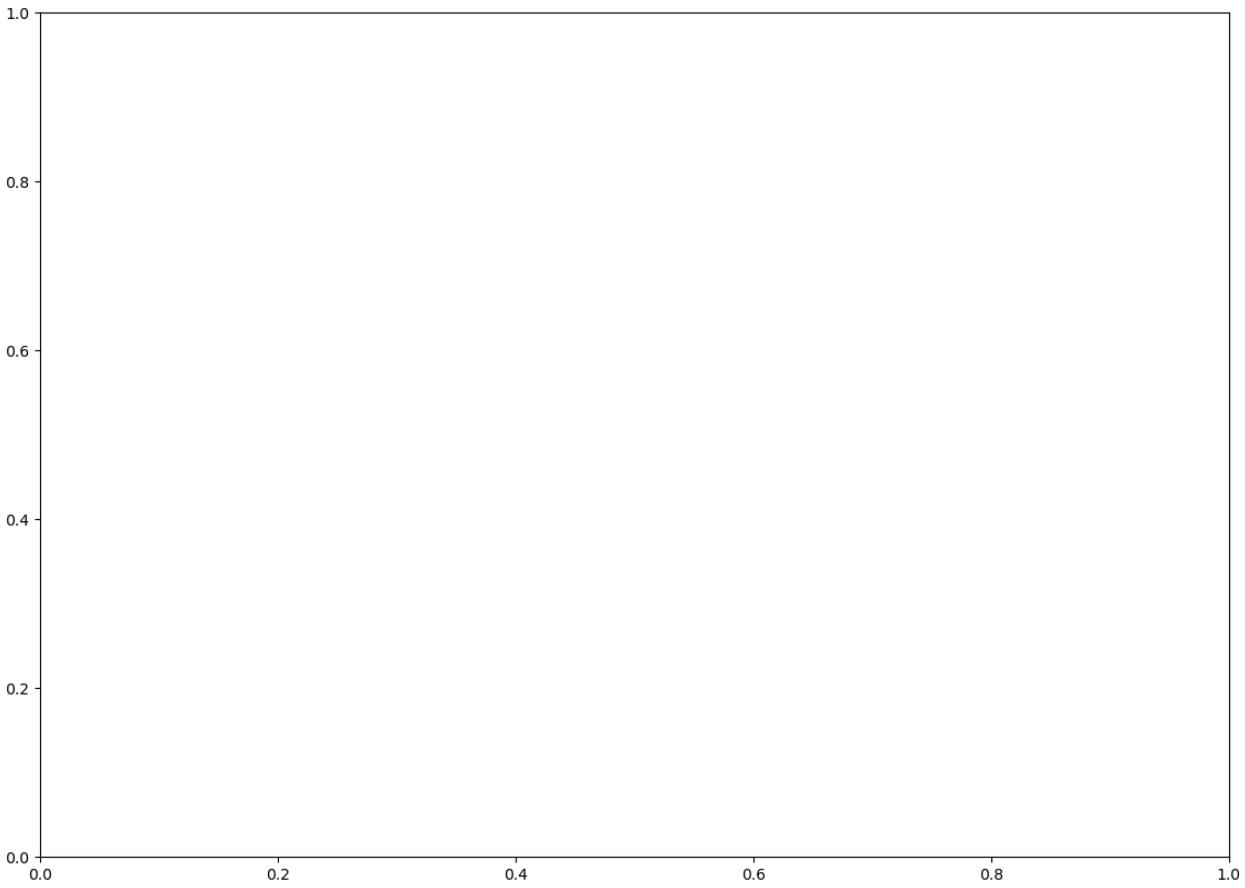


In [27]:
```
daily_returns = combined_returns_2022['Benchmark_Returns']
rolling_annual_volatility = daily_returns.rolling(window=30, min_periods=

plt.figure(figsize=(10, 6))
plt.plot(combined_returns_2022['Date'], rolling_annual_volatility, label=
plt.title('Rolling Monthly Volatility')
plt.xlabel('Date')
plt.ylabel('Monthly Volatility')
plt.grid(True)
```



In [11]:
```
import numpy as np

# Calculate rolling annual volatility and Sharpe ratio for the strategy
daily_returns = combined_returns_2022['0']  # Strategy daily returns
min_periods = 20
rolling_annual_volatility = daily_returns.rolling(window=30, min_periods=
rolling_sharpe_ratio = daily_returns.rolling(window=30, min_periods=min_p

# Plotting
fig, ax = plt.subplots(1, 1, figsize=(14, 10))

# Rolling Annual Volatility
ax[0].plot(combined_returns_2022['Date'], rolling_annual_volatility, labe
ax[0].set_title('Rolling Monthly Volatility')
ax[0].set_xlabel('Date')
ax[0].set_ylabel('Monthly Volatility')
ax[0].grid(True)

'''# Rolling Sharpe Ratio
ax[1].plot(combined_returns_2022['Date'], rolling_sharpe_ratio, label='Sh
ax[1].set_title('Rolling Sharpe Ratio')
ax[1].set_xlabel('Date')
ax[1].set_ylabel('Sharpe Ratio')
ax[1].grid(True)'''

plt.tight_layout()
plt.show()
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[11], line 13
     10 fig, ax = plt.subplots(1, 1, figsize=(14, 10))
     12 # Rolling Annual Volatility
---> 13 ax[0].plot(combined_returns_2022['Date'], rolling_annual_volatility, label='Annual Volatility', color='red')
     14 ax[0].set_title('Rolling Monthly Volatility')
     15 ax[0].set_xlabel('Date')

TypeError: 'Axes' object is not subscriptable
```

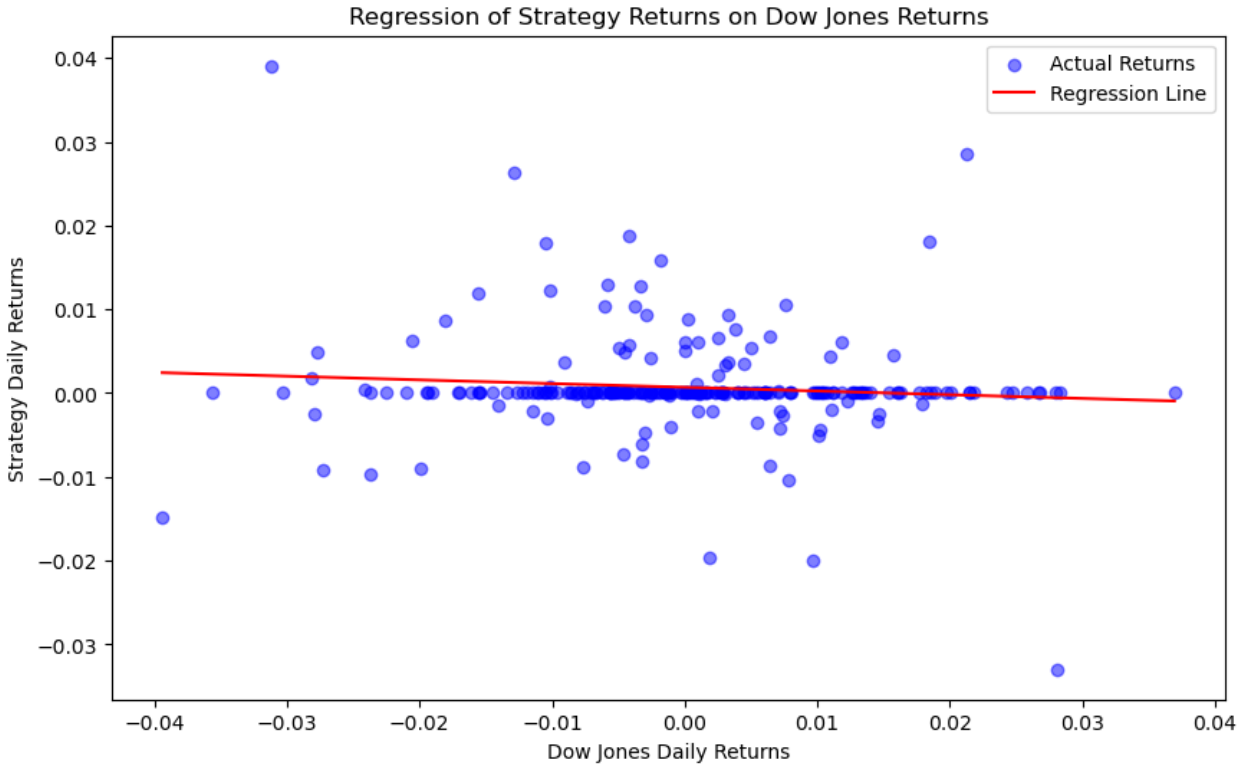


In [ ]:

In [19]:
```
# The slope of the regression line (beta) represents the strategy's portf
#strategy_beta = model.coef_[0]
from sklearn.linear_model import LinearRegression

X = combined_returns_2022[['Benchmark_Returns']]  # Independent variable
y = combined_returns_2022['0']  # Dependent variable (Strategy returns)

# Fit the linear regression model
model = LinearRegression().fit(X, y)

# Generate a sequence of Dow Jones returns spanning the observed range to
X_fit = np.linspace(X.min(), X.max(), 100).reshape(-1, 1)
```

```
y_fit = model.predict(X_fit)

# Plotting
plt.figure(figsize=(10, 6))
plt.scatter(X, y, color='blue', label='Actual Returns', alpha=0.5)  # Plo
plt.plot(X_fit, y_fit, color='red', label='Regression Line')  # Plot the
plt.xlabel('Dow Jones Daily Returns')
plt.ylabel('Strategy Daily Returns')
plt.title('Regression of Strategy Returns on Dow Jones Returns')
plt.legend()
plt.show()
```

```
/Users/yiyujie/anaconda3/lib/python3.11/site-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but LinearRegression was
fitted with feature names
  warnings.warn(
```



In [28]:
```
model.intercept_
```

Out[28]:
```
0.0006913625826638327
```

In [131…
```
strategy_beta
```

Out[131…
```
-0.04424452477905523
```

In [138…
```
# Calculate annual return of the strategy
annual_return_strategy = (1 + combined_returns_2022['0'].fillna(0)).prod(

# Calculate mean daily return of the Dow Jones and then its annualized me
mean_daily_return_dow_jones = combined_returns_2022['Benchmark_Returns'].
annual_return_dow_jones = mean_daily_return_dow_jones * 252
```

```
# Calculate strategy alpha using the provided formula
strategy_alpha = annual_return_strategy - (strategy_beta * annual_return_

annual_return_strategy, annual_return_dow_jones, strategy_alpha
```

Out[138… (0.4131831449406118, 0.004387888122234978, 0.41114638100362805)

In [ ]: