DV Laboratory Part B - Exercise 3

In a retail experiment, we want to understand how advertising expenditure, store location, and competition affect sales revenue. Using synthetic data, implement multiple linear regression in Python to analyze these factors. Interpret the coefficients, perform an F-test to assess overall model significance, and conduct t-tests to evaluate the significance of individual coefficients.

In [15]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
```

In [16]:
```
df = pd.read_csv("sales.csv")
```

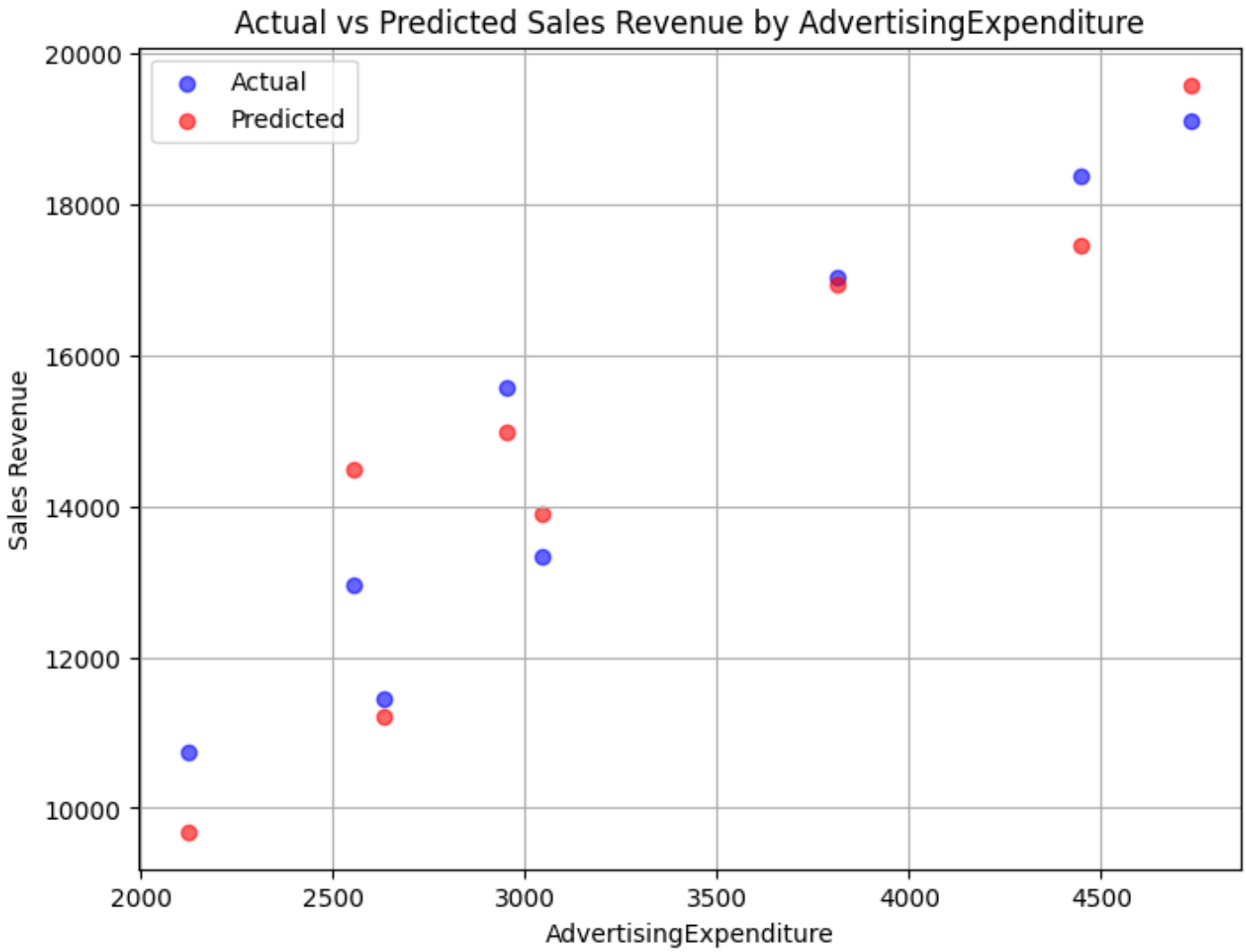
In [17]:
```
x1 = df["AdvertisingExpenditure"]
x2 = df["Competition"]
x3 = df["StoreLocation"]
x = pd.concat([x1, x2, x3], axis=1)
y = df["SalesRevenue"]
```

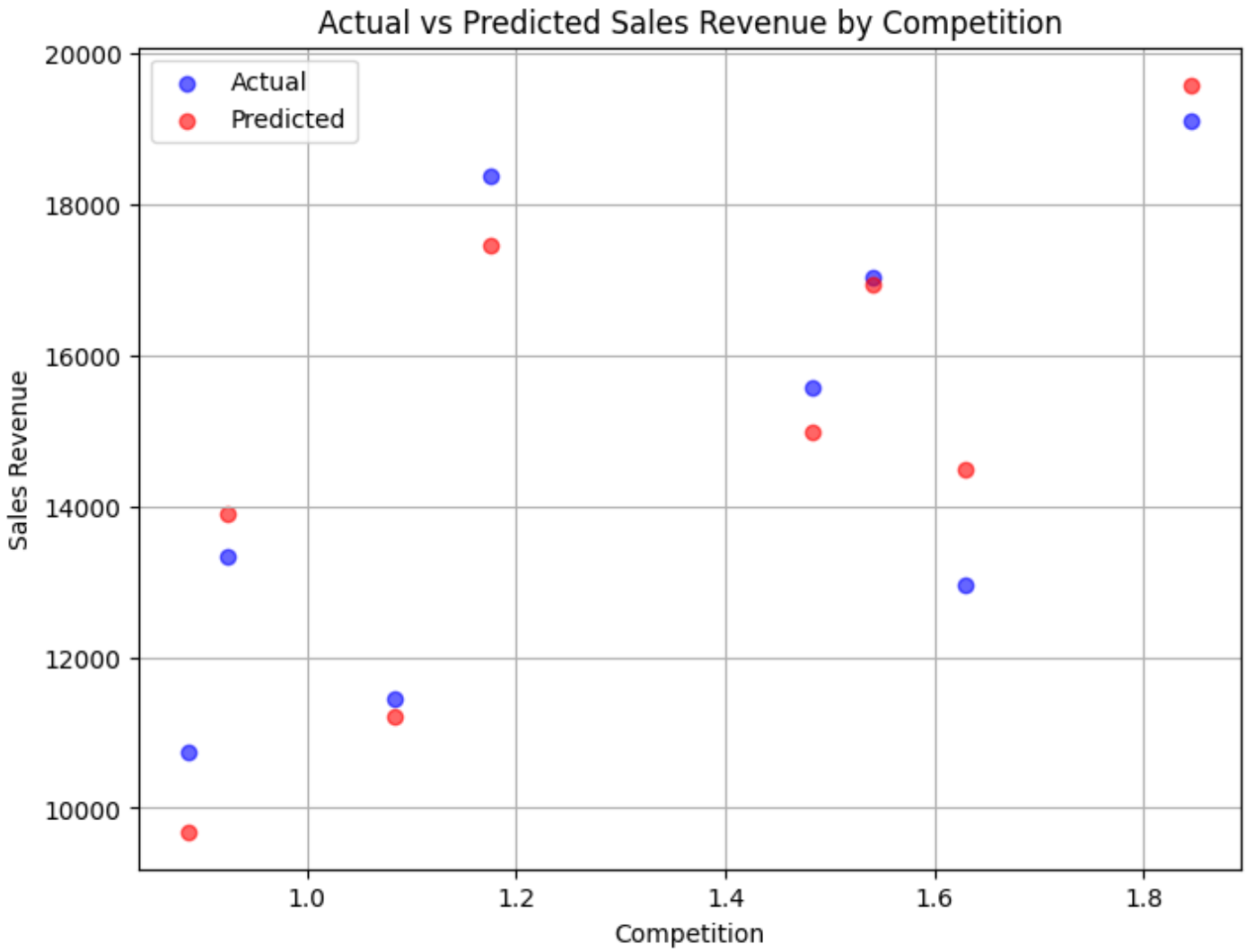
In [29]:
```
model = LinearRegression()
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25, random_state=4
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
```

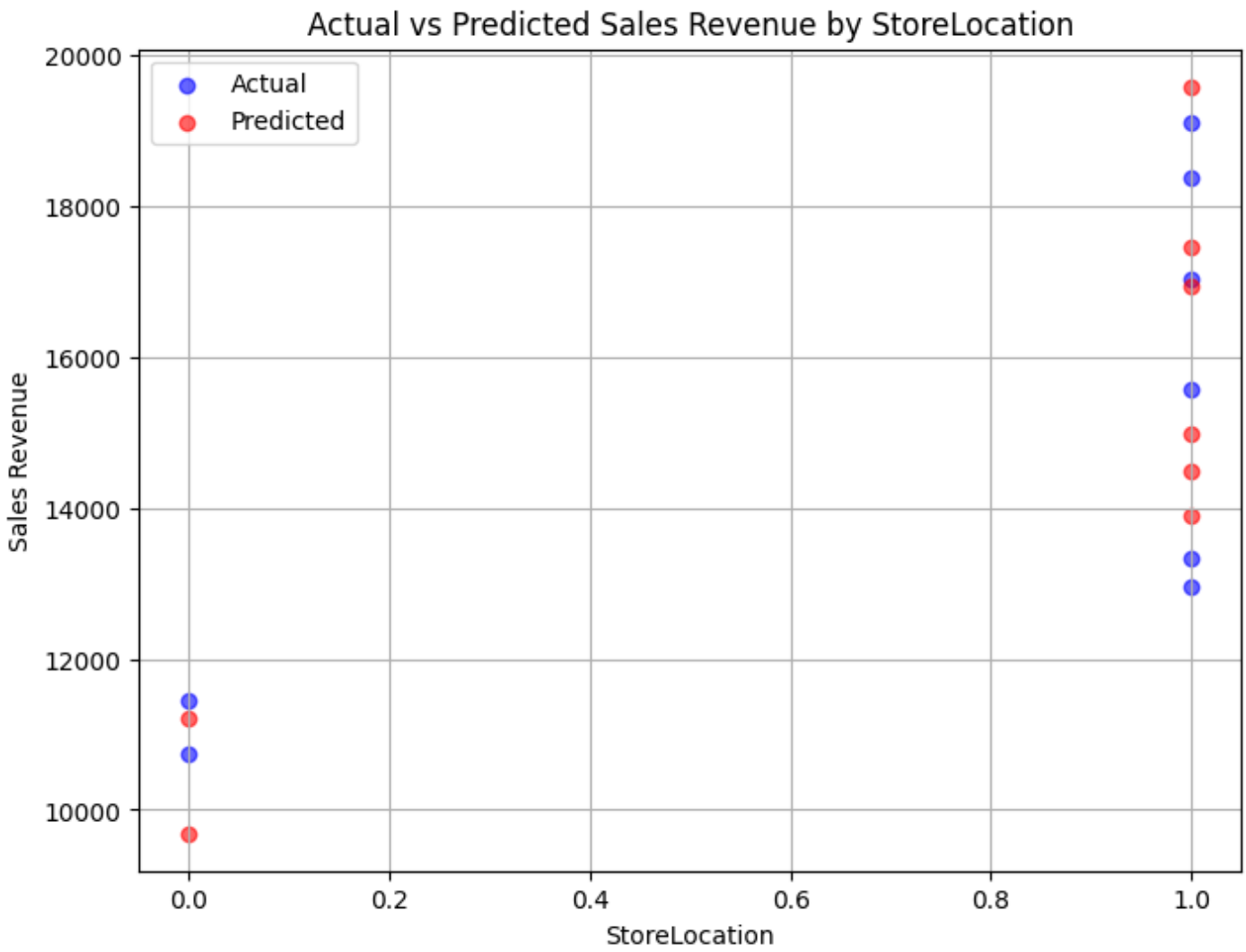
In [30]:
```
print("Coefficients:", model.coef_)
print("Intercept:", model.intercept_)
```

```
Coefficients: [2.11493691e+00 2.27274333e+03 2.19396228e+03]
Intercept: 3176.7913667305384
```

In [31]:
```
predictors = ["AdvertisingExpenditure", "Competition", "StoreLocation"]
for predictor in predictors:
    plt.figure(figsize=(8, 6))
    plt.scatter(x_test[predictor], y_test, color='blue', label='Actual', alpha=0.6)
    plt.scatter(x_test[predictor], y_pred, color='red', label='Predicted', alpha=0.6)
    plt.xlabel(predictor)
    plt.ylabel('Sales Revenue')
    plt.title(f'Actual vs Predicted Sales Revenue by {predictor}')
    plt.legend()
    plt.grid(True)
    plt.show()
```


Actual vs Predicted Sales Revenue by AdvertisingExpenditure
Actual
Predicted
Sales Revenue
AdvertisingExpenditure
20000
18000
16000
14000
12000
10000
2000
2500
3000
3500
4000
4500


Actual vs Predicted Sales Revenue by Competition
Actual
Predicted
Sales Revenue
Competition
20000
18000
16000
14000
12000
10000
1.0
1.2
1.4
1.6
1.8



In [32]:
```
import statsmodels.api as sm
import pandas as pd

X = df[['AdvertisingExpenditure', 'Competition', 'StoreLocation']]
Y = df['SalesRevenue']

X = sm.add_constant(X)

model = sm.OLS(Y, X).fit()

f_stat = model.fvalue

t_stat_advertising = model.tvalues['AdvertisingExpenditure']
t_stat_competition = model.tvalues['Competition']
t_stat_location = model.tvalues['StoreLocation']

print(f"F-statistic: {f_stat:.2f}")
print(f"t-statistic for AdvertisingExpenditure: {t_stat_advertising:.2f}")
print(f"t-statistic for Competition: {t_stat_competition:.2f}")
print(f"t-statistic for StoreLocation: {t_stat_location:.2f}")
```

```
F-statistic: 177.17
t-statistic for AdvertisingExpenditure: 12.74
t-statistic for Competition: 5.35
t-statistic for StoreLocation: 4.90
```