Yifang Zhao

In [93]:
```
import pandas as pd
import statsmodels.api as sm
```

1.) Import Data from FRED

In [94]:
```
data = pd.read_csv("TaylorRuleData.csv", index_col = 0)
```

In [95]:
```
data.index = pd.to_datetime(data.index)
```

In [96]:
```
data.dropna(inplace = True)
```

In [97]:
```
data.head()
```

Out[97]:

	FedFunds	Unemployment	HousingStarts	Inflation
1959-01-01	2.48	6.0	1657.0	29.01
1959-02-01	2.43	5.9	1667.0	29.00
1959-03-01	2.80	5.6	1620.0	28.97
1959-04-01	2.96	5.2	1590.0	28.98
1959-05-01	2.90	5.1	1498.0	29.04

2.) Do Not Randomize, split your data into Train, Test Holdout

In [98]:
```
split1 = int(len(data) * .6)
split2 = int(len(data) * .9)
data_in = data[:split1]
data_out = data[split1:split2]
data_hold = data[split2:]
```

In [99]:
```
X_in = data_in.iloc[:,1:]
y_in = data_in.iloc[:,0]
X_out = data_out.iloc[:,1:]
y_out = data_out.iloc[:,0]
X_hold = data_hold.iloc[:,1:]
y_hold = data_hold.iloc[:,0]
```

In [100]:
```
# Add Constants
X_in = sm.add_constant(X_in)
X_out = sm.add_constant(X_out)
X_hold = sm.add_constant(X_hold)
```

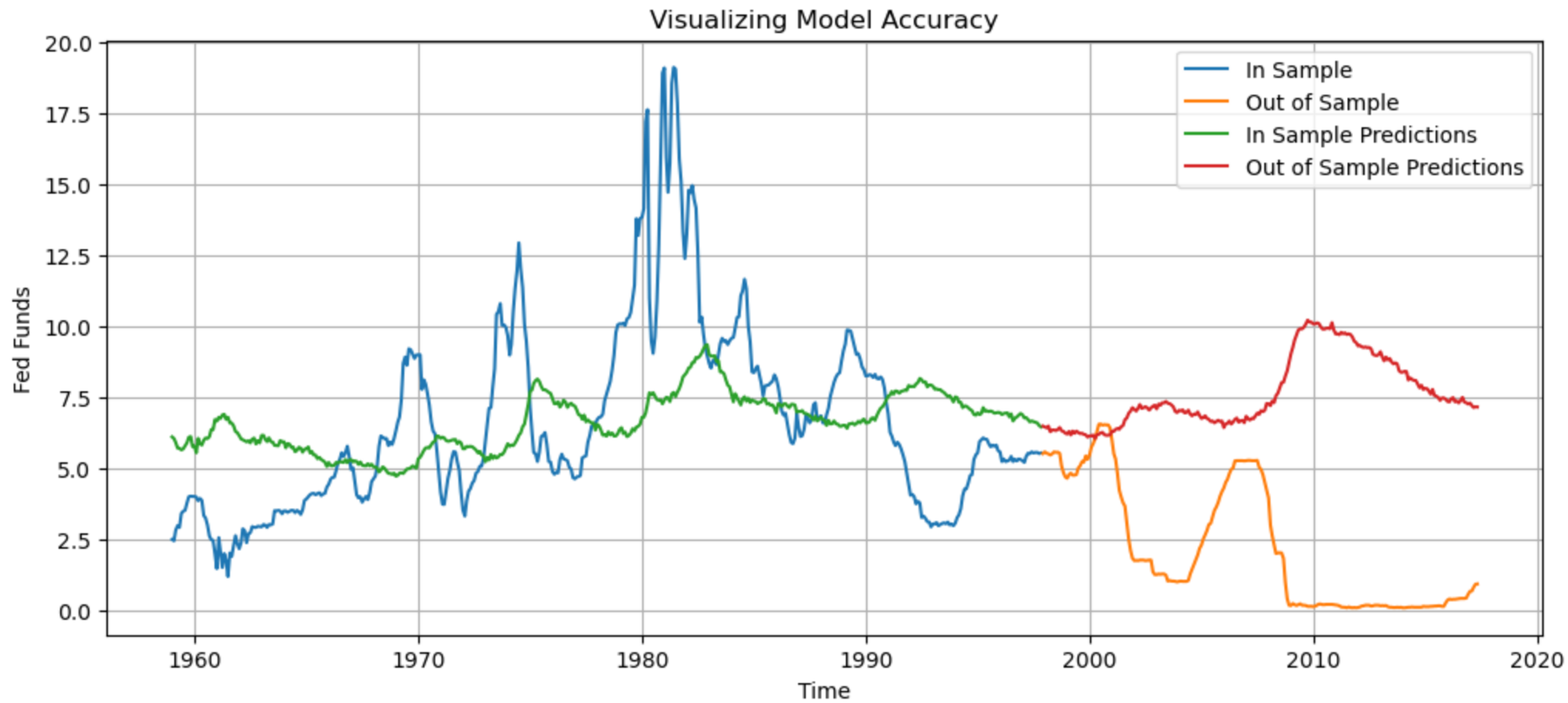
3.) Build a model that regresses FF~Unemp, HousingStarts, Inflation

In [101]:
```
model1 = sm.OLS(y_in,X_in).fit()
```

4.) Recreate the graph fro your model

In [102]:
```
import matplotlib.pyplot as plt
```

In [103]:
```
plt.figure(figsize = (12,5))

###
plt.plot(y_in)
plt.plot(y_out)
plt.plot(model1.predict(X_in))
plt.plot(model1.predict(X_out))

###

plt.ylabel("Fed Funds")
plt.xlabel("Time")
plt.title("Visualizing Model Accuracy")
plt.legend(["In Sample", "Out of Sample", "In Sample Predictions", "Out of Sample Predictions"])
plt.grid()
plt.show()
```



"All Models are wrong but some are useful" - 1976 George Box

5.) What are the in/out of sample MSEs

In [104]:
```
from sklearn.metrics import mean_squared_error
```

In [105]:
```
in_mse_1 = mean_squared_error( y_in, model1.predict(X_in))
out_mse_1 = mean_squared_error( y_out, model1.predict(X_out))
```

In [106]:
```
print("Insample MSE : ", in_mse_1)
print("Outsample MSE : ", out_mse_1)
```

```
Insample MSE :  10.071422013168643
Outsample MSE :  40.3608278356685
```

6.) Using a for loop. Repeat 3,4,5 for polynomial degrees 1,2,3

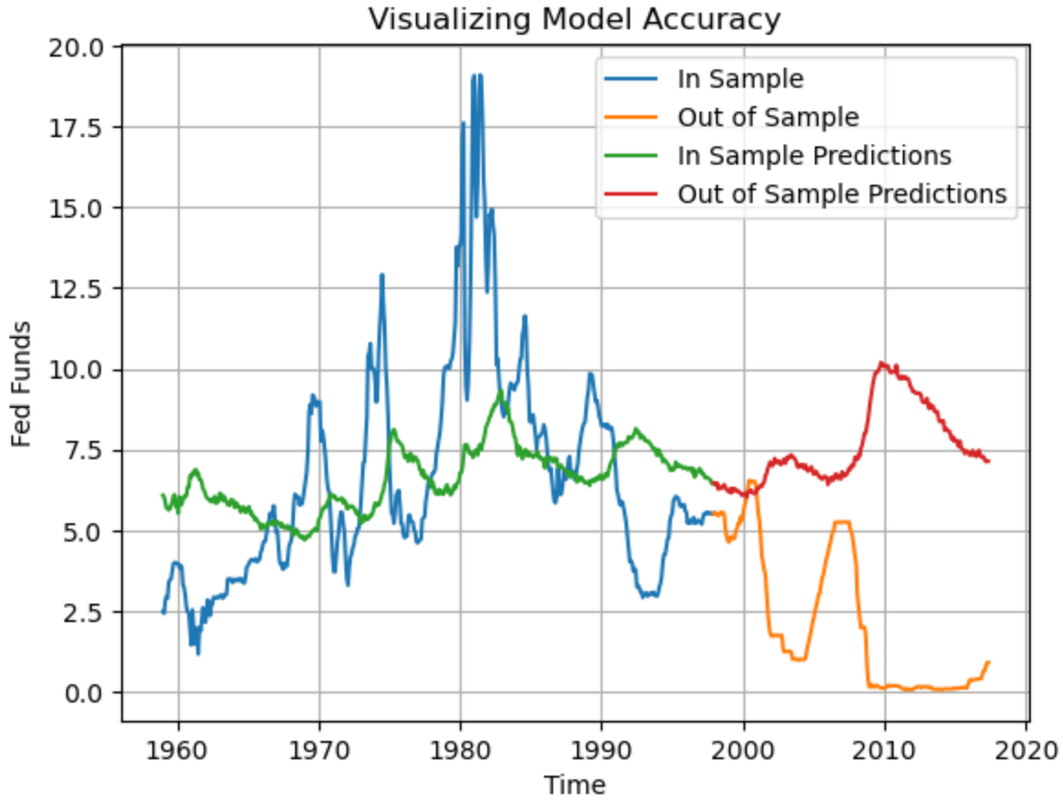
In [110]:
```
from sklearn.preprocessing import PolynomialFeatures
```

In [111]:
```
max_degrees = 3
```

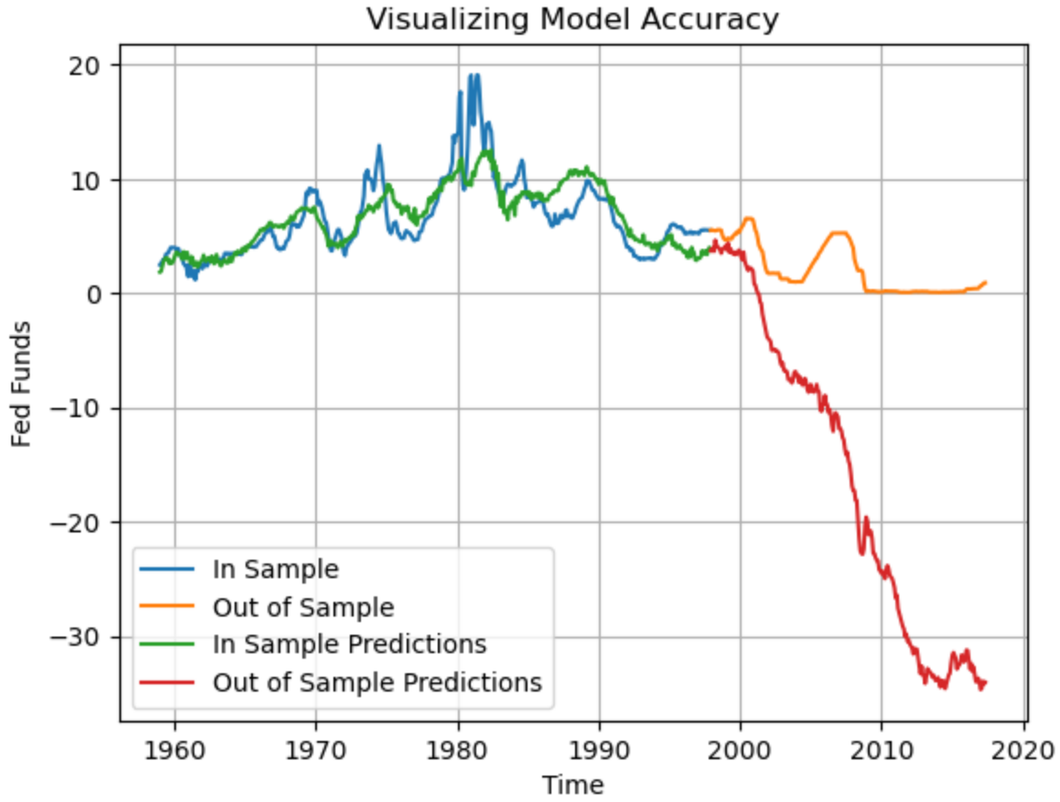
In [112]:

```
for degrees in range(1,1+max_degrees):
    print("DEGREES :", degrees)
    poly = PolynomialFeatures(degree = degrees)
    X_in_poly = poly.fit_transform(X_in)
    X_out_poly = poly.transform(X_out)

    #Q3.
    model1 = sm.OLS(y_in, X_in_poly).fit()

    #Q4.
    plt.figure

    in_preds = model1.predict(X_in_poly)
    in_preds = pd.DataFrame(in_preds, index = y_in.index)
    out_preds = model1.predict(X_out_poly)
    out_preds = pd.DataFrame(out_preds, index = y_out.index)

    plt.plot(y_in)
    plt.plot(y_out)
    plt.plot(in_preds)
    plt.plot(out_preds)

    plt.ylabel("Fed Funds")
    plt.xlabel("Time")
    plt.title("Visualizing Model Accuracy")
    plt.legend(["In Sample", "Out of Sample", "In Sample Predictions", "Out of Sample Predictions"])
    plt.grid()
    plt.show()



    #Q5.
    in_mse_1 = mean_squared_error( y_in, model1.predict(X_in_poly))
    out_mse_1 = mean_squared_error( y_out, model1.predict(X_out_poly))
    print("Insample MSE :", in_mse_1)
    print("Outsample MSE :", out_mse_1)

    print("_________________")
    print("_________________")
```

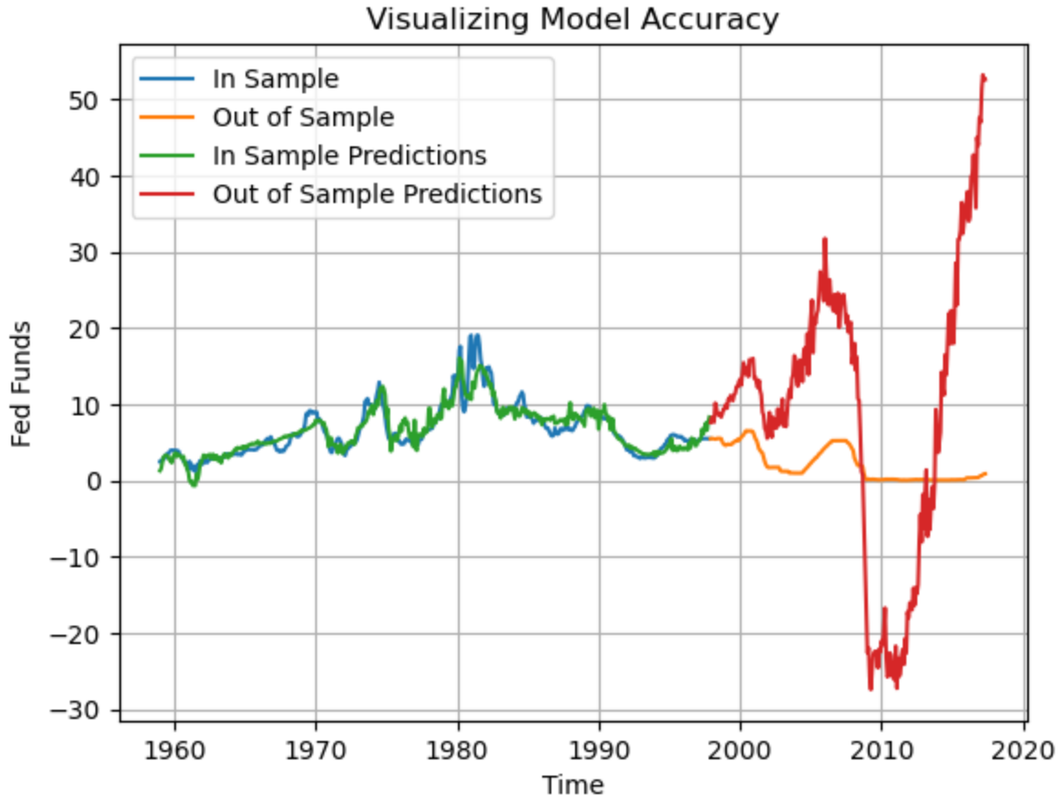
```
DEGREES : 1
```




```
Insample MSE : 10.071422013168641
Outsample MSE : 40.36082783565204

_____________
_____________
DEGREES : 2
```




```
Insample MSE : 3.863477139276068
Outsample MSE : 481.4465099024405

_________________
_________________
DEGREES : 3
```




```
Insample MSE : 1.8723636288250916
Outsample MSE : 371.7672642959744
```

7.) State your observations :

As degree increases, model becomes more and more overfitting and insample MSE becoming smaller and smaller. However ,outsample MSE becomes much bigger compare to the most simple model and reaches the highest at degree of 2. In another way ,variance is the aftermath of model overfitting.