E409 HW2

February 8, 2024

[243]:
```
import pandas as pd
import statsmodels.formula.api as smf
import numpy as np
import yfinance as yf
from scipy.stats import skew
```

1 1. Use the hw2 w24 data.csv file posted on the website for the following questions.

Variable definitions: - gap diff: The output gap difference between the US and EU. - inf diff: The inflation differential between the US and EU. - s change: The logarithmic change in the USDEUR exchange rate.

[244]:
```
df = pd.read_csv('hw2_w24_data.csv')

# Date column as index
df = df.rename(columns={'Unnamed: 0': 'Date'})
df['Date'] = pd.to_datetime(df['Date'])
df.set_index('Date', inplace=True)

df
```

[244]:

Date	gap_diff	inf_diff	s_change
2003-12-16	-1.466332	-0.036955	-0.029570
2003-12-18	-0.813845	-0.036955	-0.008251
2003-12-26	-0.807195	-0.264883	-0.000957
2004-01-16	-0.500673	-0.264883	0.003785
2004-01-17	-0.460464	-0.264883	0.002907
…	…	…	…
2023-11-16	1.564830	-0.620009	-0.027016
2023-11-17	0.643254	-0.620009	-0.004896
2023-11-25	0.636683	0.357036	-0.004701
2023-12-16	1.330083	0.357036	0.003162
2023-12-26	1.320142	0.748037	-0.010851

[717 rows x 3 columns]

[245]:
```
df.shape
```

[245]:
```
(717, 3)
```

1.1 (a)

Generate a series of linear forecasts for the logarithmic change in the exchange rate using the method shown in the lab and Papell paper with this data. However, instead of using a rolling window, use an expanding window that starts at row 120 of the provided dataframe.

[246]:
```
df['forecast'] = float('NaN')
for i in range(120, len(df)):
    forecaster = smf.ols(formula = 's_change ~ gap_diff + inf_diff', data=df[:
 ↪i]).fit() # df[:i] to get expanding window
    df.loc[df.index[i], 'forecast'] = forecaster.predict(df.iloc[i:i+1]).values
```

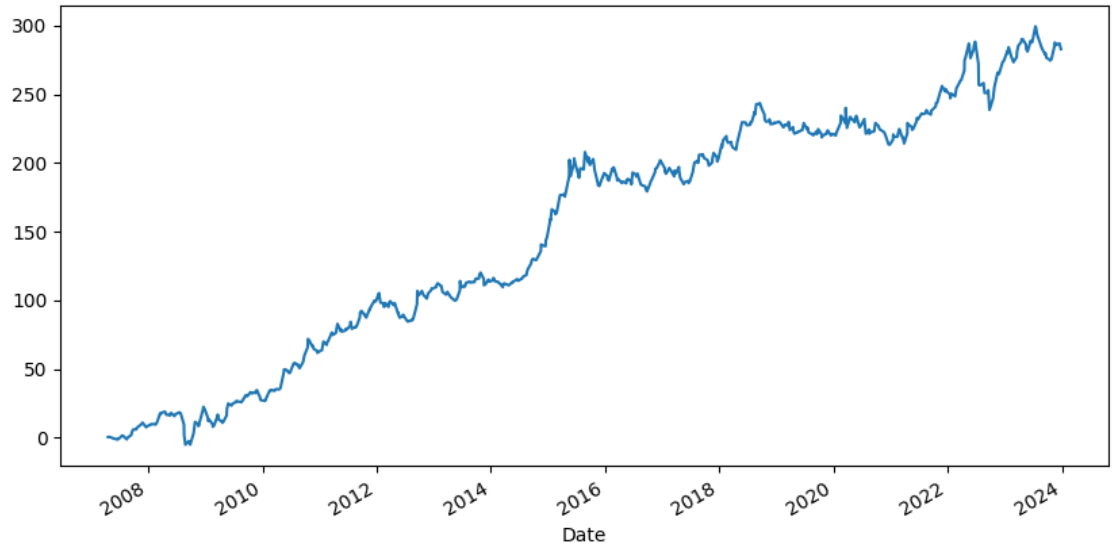
[247]:
```
# We are subsetting the datasset to the part that just conrtains our prediction
test_data = df.iloc[120:].copy()
```

[248]:
```
# Select the correct signal values
test_data['signal'] = np.where(test_data['forecast'] >= 0, 1, -1)

# note that I have shifted the return (-1) before hand, so we don't need to .
 ↪shift() the signals
# The returns were shifted to be the appropriate label for the observations␣
 ↪when we train our regression
test_data['strategy_return'] = (np.
 ↪exp((test_data['signal']*test_data['s_change']).cumsum())-1)*100
```

[249]:
```
test_data['strategy_return'].plot(figsize = (10,5))
```

[249]:
```
<Axes: xlabel='Date'>
```



2 2. Download data from yahoo finance on the SP500 and merge this data with your forecast data (hint: you may use pd.merge asof() to accomplish this task). Calculate the returns to the SP500 over the period.

[250]:
```
# Download S&P 500 data
sp500_data = yf.download('^GSPC', start='2007-04-18', end='2023-12-26')
```

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

[251]:
```
spf = pd.DataFrame(sp500_data['Open'])
```

[252]:
```
merged_df = pd.merge_asof(test_data, spf, left_index=True, right_index=True)
```

[253]:
```
returns = np.insert(np.diff(np.log(merged_df['Open'])), 0, np.nan)

merged_df['SPreturns'] = returns
```

2.1 (a)

Perform The DMW test on your forecasts from question 1. Do they outperform the random walk? How about the Clark-West test?

[254]:
```
# Mean Squared Errors
P = len(merged_df['forecast'])
MSE_T = ((merged_df['s_change']-merged_df['forecast'])**2).mean()
MSE_R = ((merged_df['s_change']-merged_df['s_change'].shift())**2).mean()
```

```
# DMW
## V_hat
error_R = merged_df['s_change']-merged_df['forecast']
error_T = merged_df['s_change']-merged_df['s_change'].shift()

tmp = np.square(error_R) - np.square(error_T) - (MSE_R - MSE_T)
V_hat = np.sum(np.square(tmp))/P

# Statistic
DMW = (MSE_R - MSE_T)/np.sqrt(V_hat/P)

print('Since the DMW statistic is equal to '+ str(DMW)+','+' which is less than␣
 ↪the critical value (1.64),')
print('we reject the null hypothesis that the MP model does not outperform the␣
 ↪random walk model.')
```

```
Since the DMW statistic is equal to 4.961904085544267, which is less than the
critical value (1.64),
we reject the null hypothesis that the MP model does not outperform the random
walk model.
```

[255]:
```
### CW statistic
tmp2 = np.sum(np.square(merged_df['forecast'][120:]))/P
CW = (MSE_R - MSE_T + tmp2)/np.sqrt(V_hat/P)

print('Since the CW statistic is equal to '+ str(CW) + ',' + ' which is grater␣
 ↪than the critical value (1.64),')
print('we reject the null hypothesis that the MP model does not outperform the␣
 ↪random walk model.')
```

```
Since the CW statistic is equal to 5.159472248274539, which is grater than the
critical value (1.64),
we reject the null hypothesis that the MP model does not outperform the random
walk model.
```

2.2 (b)

Calculate the Sharpe ratio for the SP500 and your Papell strategy from question one. Assume the risk free rate is constant at 2% annually.

[256]:
```
merged_df['s_returns'] = (np.
 ↪exp((merged_df['signal']*merged_df['s_change']))-1)*100
merged_df['s_SPreturns'] = (np.exp(merged_df['SPreturns'])-1)*100
monthly_T = np.exp(merged_df['s_returns'].resample('m').sum())-1
monthly_SP = np.exp(merged_df['s_SPreturns'].resample('m').sum())-1
rf = (.02+1)**(1/12)-1
```

[257]:
```
excess_T = monthly_T - rf
excess_SP = monthly_SP - rf
```

[258]:
```
print('Assuming a 2% annually risk free rate, the sharpe ratio for the S&P 500␣
 ↪is '+str(excess_SP.mean()/excess_SP.std()*np.sqrt(12))+'. While our strategy␣
 ↪renders a sharpe ratio of '+str(excess_T.mean()/excess_T.std()*np.
 ↪sqrt(12))+'.')
```

```
Assuming a 2% annually risk free rate, the sharpe ratio for the S&P 500 is
0.31048670009016077. While our strategy renders a sharpe ratio of
0.24615246116393813.
```

2.3 (c)

Calculate the skew of the returns of the strategy and the SP500.

[259]:
```
skewness_T = skew(merged_df['s_returns'].dropna())
skewness_SP = skew(merged_df['s_SPreturns'].dropna())

print("Skewness of returns of our strategy:", skewness_T)
print("Skewness of returns of S&P500:", skewness_SP)
```

```
Skewness of returns of our strategy: 0.4620624460031258
Skewness of returns of S&P500: -2.134135826263183
```

2.4 (d)

Calculate and compare the annual rate of return (AR) of the strategy and the SP500.

[260]:
```
start_date = merged_df.index.min()
end_date = merged_df.index.max()

num_years = (end_date - start_date).days / 365.25  # Assuming 365.25 days per␣
 ↪year for accuracy with leap years

print("Number of years in the test data:", num_years)
```

```
Number of years in the test data: 16.689938398357288
```

[263]:
```
AR_T = ((np.exp((merged_df['signal']*merged_df['s_change']).cumsum()).
 ↪iloc[-1]**(1/num_years))-1)*100
AR_SP = ((np.exp(merged_df['SPreturns'].cumsum()).iloc[-1]**(1/
 ↪num_years))-1)*100

print("Annualized returns of our strategy:", AR_T)
print("Annualized returns of S&P500:", AR_SP)
```

```
Annualized returns of our strategy: 8.37675812542984
Annualized returns of S&P500: 7.279173434814767
```

Seems like our strategy renders an annualized return a little bit higher than the annualized return from the S&P in the period. However, I would still prefer the S&P since it has a higher Sharpe Ratio.

3 3. Describe what nowcasting is and and why it may be useful in economics.

Nowcasting refers to the process of forecasting series whose date has already passed (or current), but the official data has not been released yet. For example, economists at central banks usually nowcast the value of the first quarter of GDP throughout january and march, before the official data comes out, to get a sense of the current situation of the economy.

3.1 (a)

What is the curse of dimensionality?

The curse of dimensionality refers to the issue that ocurs when the trove of economic data released by statistical agencies, private and public surveys as well as other alternative data sources generate so many series that it becomes difficult to separate signal from noise. By adding dimensions (features) to a multidimensional state, the probability of having blank, not covered, spaces among our samples becomes high.

3.2 (b)

Why is the curse of dimensionality a problem in particular when we do nowcasting?

Right now, we could extract a lot of data from text mining, google trends, fred datasets, among many other sources. Because of the curse of dimensionality we cannot include all potential data sources in a model. This would create model instability (overfitting) and can reduce the accuracy of our models.

4 4. Please find and read the monetary policy decision made by the European Central Bank (ECB) on 1/25/2024. Also read or listen to the associated press conference. Answer the following questions:

4.1 (a)

What is the ECB saying about the Taylor Rule fundamentals? Explain the ECB's decision and their outlook for future decisions using the Taylor Rule framework.

To recapitulate, the Taylor Rule targets the federal funds rate based on the current inflation rate, and the gap between actual and potential-output.

$$i_{ff} = \pi_t + 0.5(\pi_t - 2) + 0.5(y_t - \bar{y})$$

So, regarding the fundamentals they say the following.

The euro area economy is likely to have stagnated in the final quarter of 2023. The incoming data continue to signal weakness in the near term. However, some forward-looking survey indicators point to a pick-up in growth further ahead.

Inflation rose to 2.9 per cent in December as some of the past fiscal measures to cushion the impact of high energy prices dropped out of the annual inflation rate, although the rebound was weaker than expected. Inflation is expected to ease further over the course of this year as the effects of past energy shocks, supply bottlenecks and the post-pandemic reopening of the economy fade, and tighter monetary policy continues to weigh on demand.

So, the decision was to mantain the interest rate at the same level since the Governing Council considers that the key ECB interest rates are at levels that, maintained for a sufficiently long duration, will make a substantial contribution to this goal. However, they also hint that the future decisions will be to relax monetary policy (lower interest rates) when they mention that Inflation is expected to ease further over the course of this year.

4.2 (b)

On that day, what movements did we observe in the yields on 1-year maturity government bonds for the Euro Area? (This data is available from the ECB).

That day, the 1 year maturity gov bond for the euro area decreased by aproximately 5 bps. This implies that the investors actually read the ECB statements as dovish and assigned a slightly higher probability of interest rate decreases within 1 year.

5 5. Please find and read the monetary policy decision made by the U.S. Federal Reserve on 1/31/2024. Also read or listen to the associated press conference. Answer the following questions:

5.1 (a)

What is the Federal Reserve saying about the Taylor Rule fundamentals? Explain the Federal Reserve's decision and their outlook for future decisions using the Taylor Rule framework.

To recapitulate, the Taylor Rule targets the federal funds rate based on the current inflation rate, and the gap between actual and potential-output.

$$i_{ff} = \pi_t + 0.5(\pi_t - 2) + 0.5(y_t - \bar{y})$$

So, regarding the fundamentals they say the following.

Recent indicators suggest that economic activity has been expanding at a solid pace. Job gains have moderated since early last year but remain strong, and the unemployment rate has remained low.

Inflation has eased over the past year but remains elevated

The decision was to mantain the interest rate at the same level, however, many economic agents were expecting a decrease in interest rates in march 2024, however, Jerome Powell contrarested this by saying "I don't think it's likely that the committee will reach a level of confidence by the time of the March meeting". So, the Fed is saying that decreases in interest rates will come since inflation is in a clear decreasing trend, but this will not happen as soon as expected.

5.2 (b)

On that day, what movements did we observe in the yields on 1-year maturity government bonds for the United States?

In general, the 1 year maturity government bonds for the US decreased the day of the announcement. However, it may not be all accounted to the press release of the FOMC. During the same day, the New York Community Bancorp declare losses in its commercial real estate lendings. This may bring fear to the markets, which also say eliminated in the Fed press release the statement of The U.S. banking system being sound and resilient. So even if the Fed turned out to be more hawkish, the interest rate still decreased because of the risks of future crises.

6 6. What is the theoretically predicted effect of these decisions on the exchange rate?

Since the ECB statement was relatively dovish, and the Fed statement turned out more hawkish than expected, the theoretically predicted effect on exchange rate would be an appreciation of the dollar since the Fed will mantain its high interest rates for a little bit longer.

6.1 (a)

What actually happened to the exchange rate on 1/25/2024 and 1/31/2024?

As of Jan 25th the exchange rate was of 1.0837 euros per dollar, and by Jan 31st the exchange rate increased to 1.0855. So, opposite than theoretically expected, the dollar end up with a slight depreciation.

6.2 (b)

Are the theoretical and realized moves in exchange rates consistent? If not, explain why this may have happened.

The theoretical and realized moves are not consistent. What may be happening is the other factors that occurred during that period. To mention some of these: NYCB stock fell, US labor market data proved to be better than expected, and some tech companies (apple, amazon, google) reported earnings that were better than expected. All these factors may have impacted the expectations on interest rates and, thus, the exchange rate during this period.

7 7. What does an inverted yield curve forecast?

The yield curve represents the bond yields across different maturities, especially contrasting the short and long term bonds. In normal situations, there is a preference towards liquidity, so this curve tends to be positive sloped (i.e. long term bonds need to pay higher interest rate to compensate the fact of not having the liquidity for a longer period of time). However, the curve also represents the expectatives regarding the short term interest rates over time. So, an inverted yield curve (negative slope) indicates that the markets are expecting the fed to lower their interest rates in the future. This is a sign of an expected crisis in the outlook. Empirically, we can observe that this actually fulfills: historically, whenever the yield curve has a negative slope, some periods after the economy falls into recession.