Application of Matlab for Finance

October 8, 2017

Today's Class

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- Drawdown Curve (Optional)

Obtain Data from External Source: FRED

- Today, we will use Matlab to retrieve data from external sources.
- Download the historical price of S&P500 index for Jan/2008-July/2017.
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- ensure the 'Datafeed' package is properly ins
- `yahoo` is another build-in connection in Matl working since April 2017 when Yahoo changed i
- Other connections include `blp` for Bloomberg, `ravenpack` for RavenPack News Analytics, both of which require information on relevant terminals.

Obtain Data from External Source: FRED

```
1  c = fred; % connect to FRED
2  ticker = 'SP500'; % define the ticker of the stock
3  start_date = '2008/01/01';
4  end_date = '2017/07/31';
5
6  d
7  c
```


- r from connection c within specified dates
- The information is stored in a *structu*
- Accessing the *fields* of `data` using dot (.
  - `data.Data`: the `Data` field of structure variable `data`
  - `data.SeriesID`: the `SeriesID` field of structure variable `data`
- Always remember to close the connection `close(c)`.

Clear Data with Missing Observations

- Time series data may contain missing observations (ie. `NaN`).
- Consider a $(T \times N)$ price matrix with T observations on N stocks.
- We want to delete the days if any stock price on that day is missing.
- `NaN`
- `t any ( , ) == NaN missing(t,1)=1.`
- The corresponding row `t` with `missi`
  deleted by setting `=[]`;
- Note: `any(..,2)` specifies the operatio i

```
1 %% Clear missing observations
2 missing = any(isnan(data.Data),2);
3 data.Data(missing,:)=[];
```

```
%% Read Data & Calculate Returns
spy_t = data.Data(:,1); % read serial timevalue number
% convert date number to string with specified format
spy_t_str = datestr(spy_t,'dd/mm/yyyy')
% read historical price
spy_p = data.Data(:,2);
% calculate continuous return
spy_lnret = tick2ret(spy_p, spy_t, 'continuous');

f
h
```


- column 1 and price in column 2.
- The serial datetime number records time in num is necessary for time series analysis and figure plo
- Use function `datestr()` to convert dat date string, or vice versa with `datenum()`.
- `tick2ret()` calculates the *continuous* return of `spy_p` with time sequence `spy_t`.
- The `histogram` shows that the return distribution is rather symmetric.

Calculate Moving-Average Series

- A moving average at time t with n-day window is the arithmetic average of price from $t - n + 1$ to t: $MA\_21_t = \frac{p_t + p_{t-1} + \ldots + p_{t-20}}{21}$


```
% short-term simple moving average 21 days
sma_st = tsmovavg(spy_p, 's', 21, 1);
```


- column price vector, `spy_p`, for 21 days an
- The last input `1` specifies it is the column na
- Other MA calculation includes exponential, .
- In finance, we use working day counting, instead of calender days.
  - 21 days: 1 month
  - 126 days: 6-month
  - 252 days: 1 year

Plot the MA time series

```
clf % clear the previous figure
figure
plot(spy_t,spy_p,'b--',spy_t,sma_st,'g',spy_t,sma_lt,'r')
legend('SPY Price', 'SMA(21)', 'SMA(126)', ...
    'Location','northwest')
d
x
d
y
title('MA-CrossOver Trading Strategy')
```


- `plot(x,y1,x,y2,x,y3,..)` plots various graph, `x,y1,y2,y3` are of the same length.
- `x` needs to be numerical and hence we use the date number `spy_t`
- `'b','g','r'` specify corresponding line color.
- `'--'` specifies line type: dashed line.
- `datetick('x')` converts the x ticks into date string.

Plot the MA time series

The MA Cross Trading Strategy

- The MA cross trading strategy uses technical analysis on past prices
  - **Buy signal** when the short-term trend cross-up long-term trend from bottom -> buy and hold position when sma_st > sma_lt
  - **Sell signal** when short-term trend cross-down long-term trend from

The MA Cross Trading Strategy


```
1 % buy when sma_st > sma_lt, sell when sma_st < sma_lt
2 position = (sma_st > sma_lt)*2 - 1;
```


- Note: Code `position=(sma_st>sm` ding strategy that you buy the stock after a buy signal an underlying after a sell signal. `positi` `t`.
- Note: Code `position=(sma_st>sma_lt)*2-1` is the relative **active** trading strategy that you engage in short selling activity after a selling signal by setting `position =-1` when `sma_st<sma_lt`.

SubPlot


```
1 subplot(2,1,1)
2 plot(spy_t,spy_p, spy_t, sma_st, spy_t, sma_lt)
3 s
4 p
```


- The actual plot codes of plotting comes after `subplot(m,n,p)`.
- `m,n` define the plots layout structure:
- `p` defines which sub-plot panel is defined in th

- In above code, we create a figure with 2
  - the first panel plots the price and moving-average.
  - the second panel plots the position.

Plot the Trading Position


```
figure
subplot(2,1,1)
p
l

d
x
datetick('x')

subplot(2,1,2)
plot(spy_t, position,'LineWidth',2)
xlim(dates_limits)
datetick('x')
```

Plot the Trading Position

Calculate Returns


```
1 %% Calculate returns
2 %daily and cumulative return on the MA strategy
3 strategy_ret =  position(2:end).*spy_lnret;
4 c
5 % c
6 c
```


- `strategy_ret` is the daily return based on th
  - `(2:end)` as the 1st-day has no return yet;
  - note: we use element-by-element multipli
- Use `cumsum` as we work with ln return; and use t t back to cumulative simple return for comparison.
- The market benchmark assumes a buy and hold trading strategy.

Plot the Cumulative Return


```
figure
plot(spy_t(2:end), cumret_strategy,'b');
hold on % hold on the previous plot
plot(spy_t(2:end), cumret_market,'g');
l
d
x
d
ylabel('Cumulative Return ')
```


- `hold on` retains plots in the current axes so tha the axes, otherwise, the new plots will overwrite t
- `spy_t(2:end)` as we plot returns now.
- From the plot, it is clear that the trading strategy outperforms the market itself.

Plot the Cumulative Return

Annual Summary Statistics


```
%% Calculate Annual Return
annual_ret = mean(spy_lnret) * 252;
annual_std = std(spy_lnret) * sqrt(252);
% assuming the rf = 0.03
s

%c
r
disp(['The annual return, stdeve and Sharpe Ratio are: ...
    ',num2str(res)])
```


- Annualise daily in return by multiplying 252, the days in a year.
- Annualise standard deviation by multiplying square root of 252.
- Assume a relevant annual risk-free rate to calculate Sharpe ratio.

Construct Drawdown Curve

- A drawdown curve evaluates the performance of a trading strategy against its own best performance. $DD_t = \frac{HWM - R_t}{R_t}$
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- At $t = 2$, the trading strategy makes a return, b
  - 1.2 < HWM =1.5 → HWM =1.5 sta
  - drawdown = (1.5-1.2)/1.2 =0.25

- A peak in the drawdown curve is the maximum loss in the profits from the highest profit point in history

Construct Drawdown Curve


```
%% Calculate the Drawdown Curve
% set HMW = 1 for start with.
h
T = l
d
f

        high_water_mark = cumret_stra
    end
    drawdown = (high_water_mark -
        cumret_strategy(t))/cumre
    dd_curve(t) = drawdown;
end
```

Plot the Drawdown Curve

Take Away

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- The concept of drawdown curve in asset manag
evaluation