QF603 Behavior Finance

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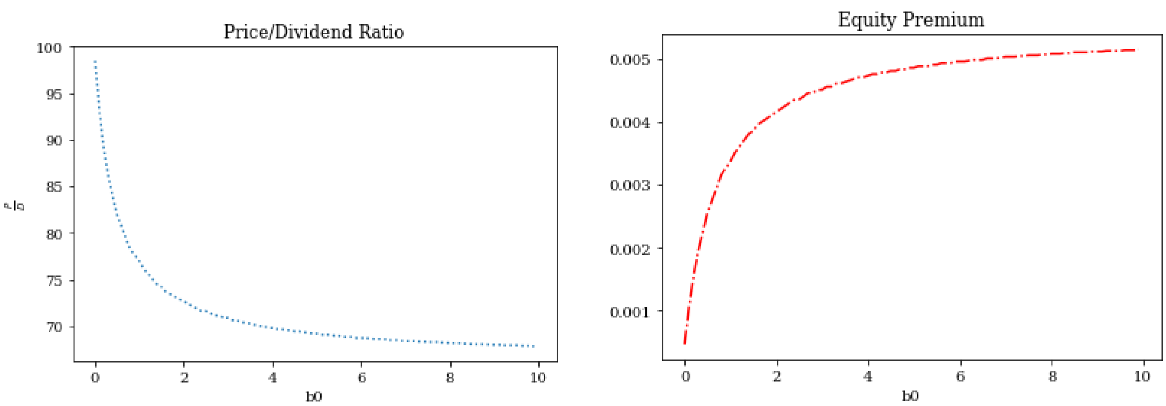
Nov 24th 2018

1 Behavioral Finance



(a) Price/Dividend Ratio

(b) Equity Premium

Figure 1

- The function calculate utility directly from the summation of the utility of comsumption and utility of recent financial gain or loss without a pricing kernel.
- b0 measures the degree of prospect effect. A higher b0 means more impact of previous financial gain or loss on investor's utility (relative to consumption), which shows on the figures as higher euity premium and lower price/divident (more fruits) ratio.
- λ measures the degree of loss reversion. λ larger than 1 means one loss more satisfaction when suffering from certain amount of loss compared to gain the same amount of profit.

2 Python Code

Listing 1: Python Code

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

plt.rcParams['font.family'] = 'serif'
plt.rcParams['figure.facecolor'] = '1.'

# lock the random
np.random.seed(1)

# simulate epsilon
epsilon = np.random.randn(10000, 1)

# calculate ln(g)
ln_g = 0.02 + 0.02 * epsilon
```

```
# calculate g
g = np.exp(ln_g)

plt.plot(g)
plt.title('g')
plt.show()

M = 0.99 * g**(-1)

PD = np.mean( 0.99*g**(1 - 1) )

def e(x, b0, lambd = 2):

        def v(array):
                ind0 = array >= 1.0303
                ind1 = array < 1.0303

                value = np.zeros(array.shape)
                value[ind0] = array[ind0] - 1.0303
                value[ind1] = lambd*( array[ind1] - 1.0303 )

                return value

        error = 0.99*b0*( np.mean(v(x*g)) ) + 0.99*x - 1

        return error

def bisection_search(function, guess_minus, guess_plus):
        '''Bisection search optimization
        Find out the x_ that makes function(x_) appoaximate to 0 (1e-4).
        *function* must be continuous.
        *function(guess_minus)* and *function(guess_plus)* must have opposite signs.

        Input:
        --- function: The objective function to be optimized.
        fun(x, *args) -> 0

        --- guess_minus: One end of the bracketing interval [x-, x+].
        float or integer

        --- guess_plus: One end of the bracketing interval [x-, x+].
        float or integer

        Output:
        --- x_: optimal x that satisfies fun(x, *args) -> 0
        float
        '''
        # guarantee the optimal x is in [x-, x+]
        assert function(guess_minus)*function(guess_plus)<0,\
        '*function(guess_minus)* and *function(guess_plus)* must be sign changing values'

        # switch the position if the negative and positive bound are reversed
        if function(guess_minus) > 0:
                guess_minus,  guess_plus = guess_plus, guess_minus

        # assign the current optimal guess to x_
        if abs( function(guess_minus) ) > abs( function(guess_plus) ):
                x_ = guess_plus
        else:
                x_ = guess_minus
```

```
        # optimization goal is 1e-4
        while abs( function(x_) ) > 1e-4:
                # take the midpoint as new bound.
                x_ = (guess_plus + guess_minus)/2

                # update guess_plus/guess_minus
                if function(x_) > 0:
                        guess_plus = x_
                else:
                        guess_minus = x_

        return x_

b_array = np.arange(0, 10, 0.1)

x_array = np.array( [bisection_search(lambda x, b0 = b: e(x, b0), 1., 1.1 ) for b in b_arra

PD_array = np.array( [1/(x - 1) for x in x_array] )

ERM_array = np.array( [np.mean(x*g) for x in x_array] )

Rf = 1/np.mean(0.99*g**(- 1))

plt.plot(b_array, PD_array, ':' )
plt.title('Price/Dividend Ratio')
plt.xlabel('b0')
plt.ylabel('$\\frac{P}{D}$')
plt.show()

plt.plot( b_array, ERM_array - Rf, 'r-.' )
plt.title('Equity Premium')
plt.xlabel('b0')
plt.show()
```