Trading Project Report

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Based on the Asset allocation process, I am risk-tolerant. So for me I would set 5% of my complete portfolio as risk-free asset like T-bills, the rest part would be mainly stocks and options, using *Black-Scholes model* (Black and Scholes 1973) to hedge risk.

About trading stocks, as a student in math department, I personally preferred using certain algorithms following their historical data, to find some criteria on when to purchase or sell and how much should I invest. Back in China, several efficient platforms are highly recommended like RiceQuant, UQER. The most common algorithm is *Pairs Trading* (Gatev, Goetzmann and Rouwenhorst 2006), that for two stocks or portfolios with similar movement historically, short the winner and buy the loser when the price spread increase then profit when they converge. Another strategy based on the companies' financial data coming from the idea of Graham, value investment. I can set several ranges for each data and choose the stocks that satisfy to invest. However, a bitter truth is that for most of the time, strategies based on value investment win the others. One of those most famous value investment masters is Anthony Bolton (Bolton and Davis 2006), who is distinguished for his Fidelity Special Situations Fund. Sometimes you're required to be a "contrarian". My last belief is that everything is formed in a self-similar pattern from fractal geometry, so that the price charts in a longer time period should be similar to a smaller time period, which can be seen from another famous model LPPL (Fantazzini and Geraskin 2011) that successfully predicted the great loss in 2008, China.

Equity analysis

Since it's a much lower frequency trading like once a week, companies who are underpriced or facing a big opportunity will be my major concerns.

Recently *Costco Wholesale Corporation* announced a new delivery services in response to *Amazon*'s recent action on its delivery services. I think such competition will make profit. So I do equity analysis on these two first.

COST (Variety shop)

With data obtained online[1], I then implement the statistics method using Excel[2]. Among the 1257 observations, the minimum price is $\$77.8725$ while the maximum is $\$181.62$, and the mean and standard deviation is $\$127.2940$ and $\$25.4854$, respectively.

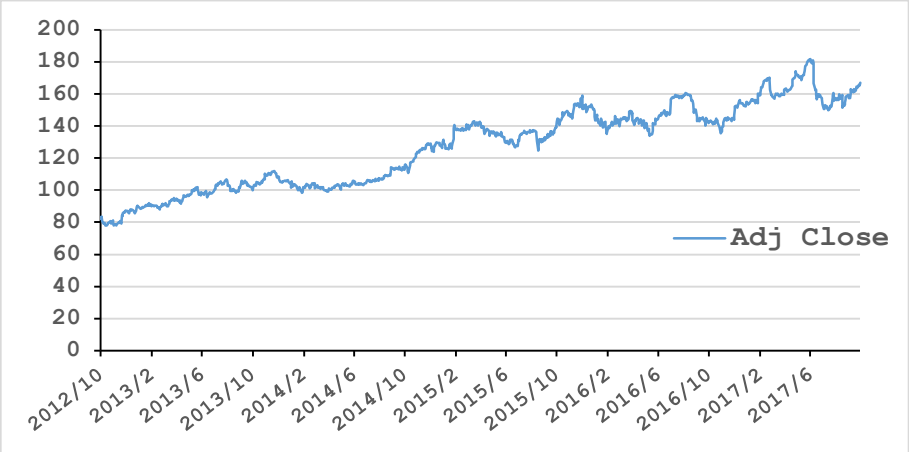

Fig 1 Price Change of COST

Then I sort out of the monthly price data to find the monthly return rate. The following is the historical return, with a 1.05% standard deviation.

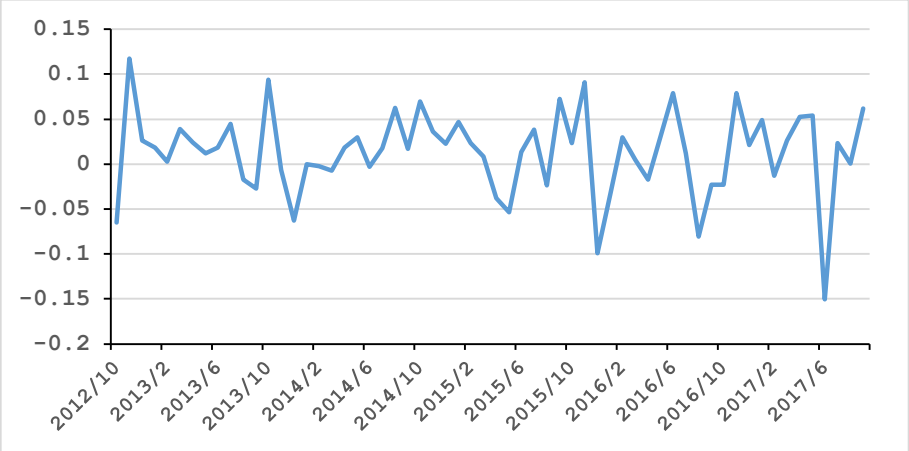

Fig 2 Monthly Return Rate of COST

[1] https://finance.yahoo.com/quote/COST, others are also from Yahoo Finance.

[2] Microsoft® Excel®

The β of COST is calculated based on the S&P 500 index and the least 3-month T-bill rate, 1.03%. After regression, the result is $\beta = 1.92631140004198$, while the value posted is 1.03.

The last step is applying the DDM model. Its Return on Equity is 23.19%; Payout Ratio is 32.12%; 5 Year Average Dividend Yield is $\$1.05$. For the required rate of return

$$\begin{aligned} k &= r_f + \beta(r_M - r_f) \\ &= 12 \times (1.03\% + 1.9263 \times (1.19\% - 1.03\%)) \\ &= 16.06\% \end{aligned}$$

And in order to use DDM, I have to assume that it is with a constant growth rate

$$\begin{aligned} g &= \text{ROE} \times b \\ &= 23.19\% \times (1 - 32.12\%) \\ &= 15.74\% \end{aligned}$$

$$\begin{aligned} V_0 &= \frac{D_1}{k - g} \\ &= \frac{1.05}{16.06\% - 15.74\%} \\ &= 329.67 \end{aligned}$$

And its current price is no more than $\$160$. Seems that I got a good one.

AMZN (Catalog & Mail Order Houses)

Following the same method, I plot its close price first. This time and later, I will use the monthly data directly given by Yahoo Finance.

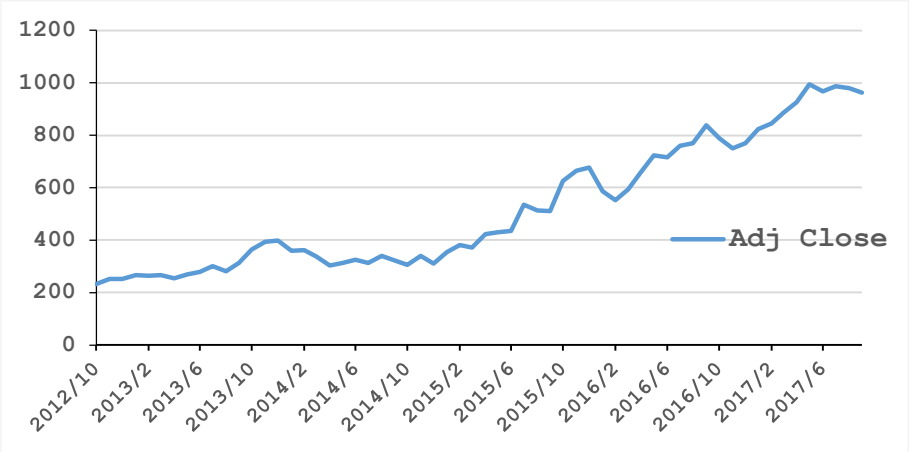

Fig 3 Price Change of AMZN

And the month return rate figure of AMZN

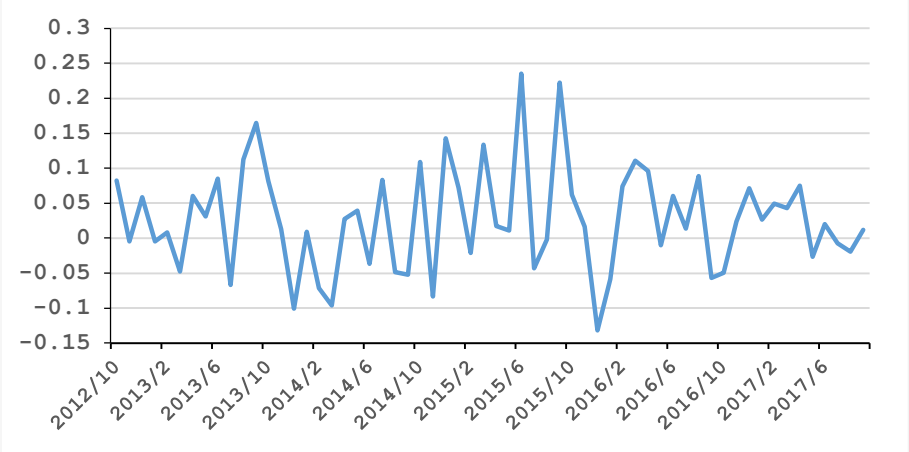

Fig 4 Monthly Return Rate of AMZN

Then using the regression to calculate β, which is 1.44162 (the value posted is 1.31). The last step is applying the DDM model; while AMZN didn't pay any dividends so far, so I may choose another one to complete this analysis.

SJM (Processed & Packaged Goods)

I love the jam they produce, and they pay dividends! So here's the analysis result.

Among the 60 observations, mean price level is about $\$107.50$, ranging from $\$76.44$ to $\$149.84$, mean return rate level is about 0.648%, a tiny number, and the return rate goes from -14.061% to 18.615%. The following is its price trend.

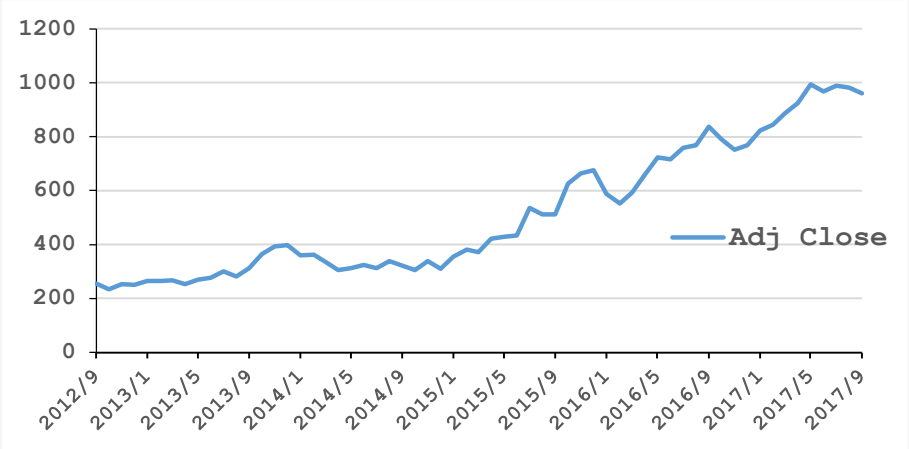

Fig 5 Price Change of SJM

And its trend of return rate.

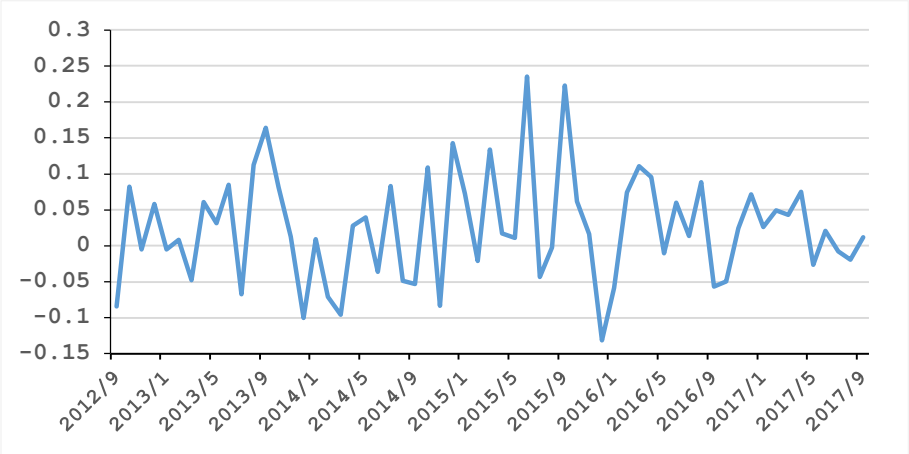

Fig 6 Monthly Return Rate of SJM

The β by regression is 0.63, while the posted value on Yahoo Finance is 0.36.

As for DDM model, its Return on Equity is 7.83%; Payout Ratio is 63.03%. 5 Year Average Dividend Yield is $\$2.20$. I calculate the required rate of return

$$\begin{aligned} k &= r_f + \beta(r_M - r_f) \\ &= 12 \times (1.03\% + 0.63 \times (1.19\% - 1.03\%)) \\ &= 13.5696\% \end{aligned}$$

And still, after I have to assume that it is with a constant growth rate

$$\begin{aligned} g &= \text{ROE} \times b \\ &= 7.83\% \times (1 - 63.03\%) \\ &= 2.90\% \end{aligned}$$

$$\begin{aligned} V_0 &= \frac{D_1}{k - g} \\ &= \frac{2.20}{16.06\% - 2.90\%} \\ &= 20.6193 \end{aligned}$$

And its current price is about $\$105$. I believe this time the DDM model failed, since generally that model is only fit for those regulated public utilities.

APPL (Electronic Equipment)

Apple Inc. recently release its new mobile phone, iPhone X. To be frank, its appearance shocked me completely. However somehow, it's still worth an investment. Not only do they

pay dividends, but also “the rich” will not refuse to show off their wealth in such a chance, even not their real wealth. Like some fashion forward designs, they may soar up the sky later and Apple is meant to be a dragon not a dragon fly. See the analysis result.

For APPL’s price change, it ranges from $52.05 to $163.36 with mean $98.65; and for its return rate, it ranges from −14.4% to 14.1% with mean 1.22%. See the figures below for more details

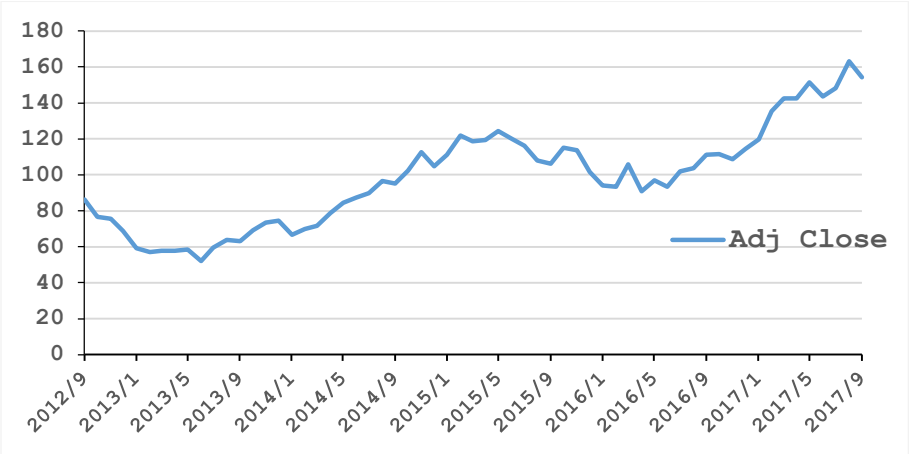

Fig 7 Price Change of APPL

And the trend for the return rate

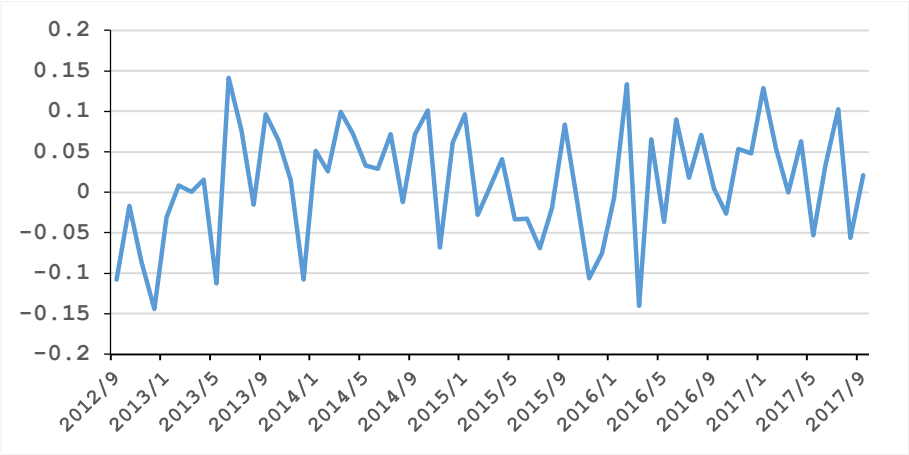

Fig 8 Monthly Return Rate of APPL

The β by regression is -0.26, posted value is 1.39; such a difference! Now I am questioning whether it is right to using a five-year-long period to analysis for all kinds of stocks. But perhaps I should stop here because there're still many other projects to do which are due next week, and I may keep researching during the winter break.

As for DDM model, its Return on Equity is 36.03%; Payout Ratio is 26.50%. 5 Year Average Dividend Yield is $\$1.83$. Then after assuming the constant growth rate

$$\begin{aligned} g &= \text{ROE} \times b \\ &= 36.03\% \times (1 - 26.50\%) \\ &= 26.48\% \end{aligned}$$

$$\begin{aligned} k &= r_f + \beta(r_M - r_f) \\ &= 12 \times (1.03\% - 0.26 \times (1.19\% - 1.03\%)) \\ &= 11.8608\% < \text{g} \end{aligned}$$

Guess I failed another time, bad luck.

PEP (Beverages - Soft Drinks)

Everyone drink in the dining area of KSU, and the cups they use are all with the logo of Pepsi. Also, after a month I tried KICKSTART in America for the caffeine inside, I started to realize it's a sub-brand of Pepsi. So maybe it's a good choice?

And seeing from the recent report, its quarterly results before the Oct. 4 opening bell earnings that handily beat expectations, while revenue was just slightly below the mark, similar to Intel's results. (Kilgore and Linnane 2017). Here's the analysis result

Of all the observations, the close price range from $\$59.36$ to $\$115.8$ with mean $\$57.45$; and for the return rate, it goes from -6.66% to 9.21%, with mean value 1.07%. See the below trend pictures for more details.

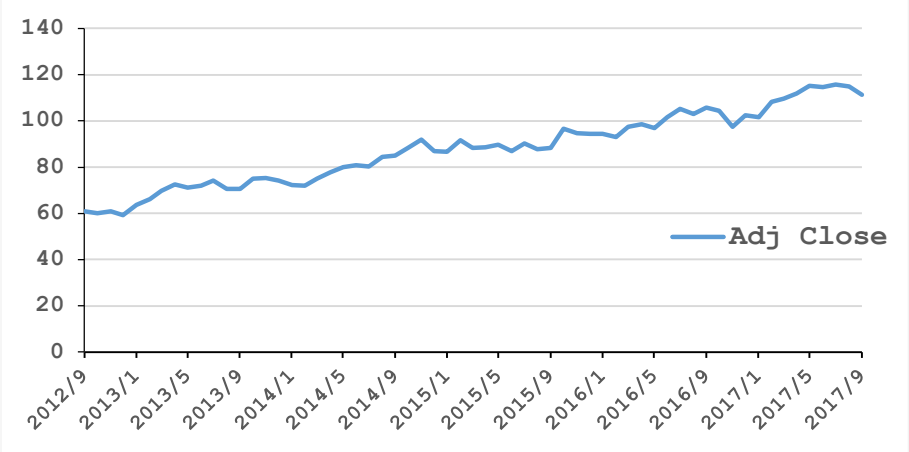

Fig 9 Price Change of PEP

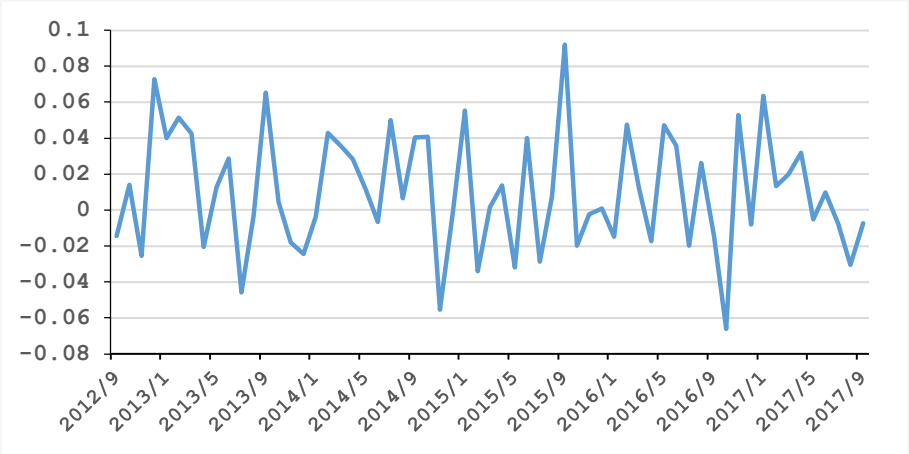

Fig 10 Monthly Return Rate of PEP

Using regression, I get the $\beta = -0.0917047228253252$ however the posted value is 0.66; then use $k = 16.38\%$ and DDM under constant growth assumption

$$\begin{aligned} g &= \text{ROE} \times b \\ &= 53.73\% \times (1 - 64.36\%) \\ &= 19.15\% \end{aligned}$$

$$\begin{aligned} k &= r_f + \beta(r_M - r_f) \\ &= 12 \times (1.03\% - 0.09 \times (1.19\% - 1.03\%)) \\ &= 12.1872\% < \text{g} \end{aligned}$$

Last try.

GE (Diversified Machinery)

So for the description of statistics, the adjusted close price range from $\$17.77$ to $\$30.55$ with mean $\$24.47$; and the monthly return rate range from -9.62% to 15.70% with mean 0.49%. More details are shown below.

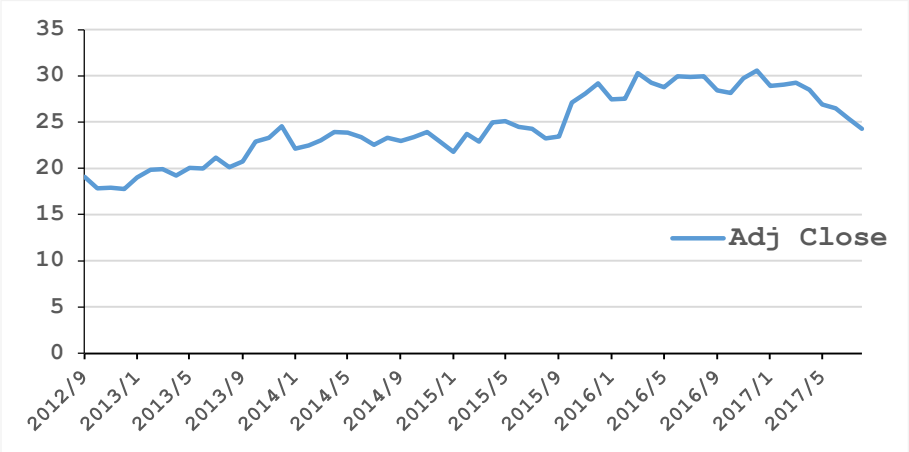

Fig 11 Price Change of GE

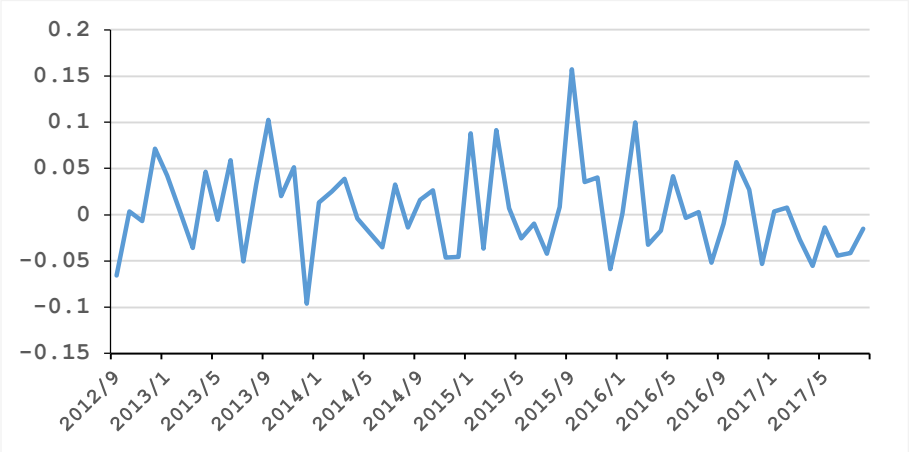

Fig 12 Monthly Return Rate of GE

Then the β, as calculated by regression is -0.23, nonetheless the posted one is 1.08. I may figure why they show such great difference later but now the main goal is to verify whether the requirements of DDM are satisfied

$$\begin{aligned} g &= \text{ROE} \times b \\ &= 9.52\% \times (1 - 109.20\%) \\ &= -0.88\% \end{aligned}$$

$$k = r_f + \beta(r_M - r_f)$$
$$= 12 \times (1.03\% - 0.23 \times (1.19\% - 1.03\%))$$
$$= 11.9184\% > \text{g}$$

$$V_0 = \frac{D_1}{k - g}$$
$$= \frac{3.24}{11.9184\% - (-0.88\%)}$$
$$= 25.32$$

Slightly higher than the price now which is only about $\$24$. Got to wait it to get down lower.

Summary Table and Reflections

Why I fail so many times? Personally, besides the reasons on the book, I figure out some others possible lurking factors. One is using the S&P 500 as the market index. It's true that it's hard to find a better one as for the whole market, but nobody uses that as an adjustment on the the price, or do it inversely.

See the summary table below for the end of this section.

Name of Stock	COST	SJM	GE
Min Close Price	77.88	76.44	17.77
Max Close Price	181.62	149.84	30.55
Mean Close Price	127.29	107.51	24.47
SD(Close Price)	25.49	17.91	3.67
Min Return Rate	-7.51%	-14.06%	-9.62%
Max Return Rate	10.99%	18.62%	15.70%
Mean Return Rate	1.22%	0.65%	0.49%
SD(Return Rate)	4.61%	5.26%	4.79%
β (posted β)	1.21(1.03)	0.63(0.36)	-0.23(1.08)
V_0 (by DDM)	164.06	16.32	20.90

V_0	157.09	103.93	20.79

Three stock portfolio Analysis

So after the equity analysis, we found the three stocks we want: COST, SJM and GE. We first normalize the price and do the following steps using Excel. Sadly, there's no such optimal risk portfolio ever exists in this case, which means that the latest 3-month T-bill rate is so high that no CAL can be formed. So we can just take all three stocks with equal weight.

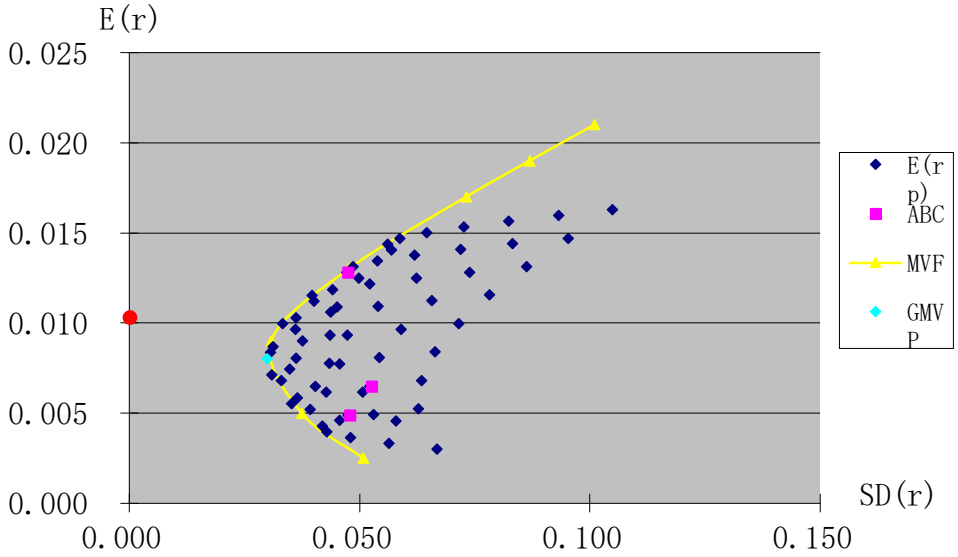

Fig 13 Risk Analysis

Degree of diversification

First we can see the coefficient matrix.

$$\begin{pmatrix} 1 & 0.061910 & 0.135259 \\ 0.061910 & 1 & -0.00613 \\ 0.135259 & -0.00613 & 1 \end{pmatrix}$$

Based on these figures, I may claim that there's no apparent correlation between any two stocks of the all three since the biggest absolute value of them is just 0.135259 which is a little bit of small comparing to the normalized price.

Portfolio β

Since they three are of equal weight, so we have

$$\beta_p = \frac{\beta_1 + \beta_2 + \beta_3}{3} = \frac{1.21 + 0.63 - 0.23}{3} = 0.537$$

Portfolio expected return

$$E(r_p) = r_f + \beta[E(r_m) - r_f] = 1.03\% + 0.537 \times (12\% - 1.03\%) = 6.92\%$$

Portfolio's excess return

$$r_p - E(r_p) = \frac{1.22\% + 0.65\% + 0.49\%}{3} - 6.92\% = -6.13\%$$

Sharpe ratio

Even there's no optimal portfolio, Sharpe ratio still calculable.

$$\sigma = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + 2 \cdot \rho_{12} \cdot \sigma_1 \cdot \sigma_2 + 2 \cdot \rho_{23} \cdot \sigma_2 \cdot \sigma_3 + 2 \cdot \rho_{31} \cdot \sigma_3 \cdot \sigma_1} = 8.974\%$$

$$S = \frac{r_p - E(r_p)}{\sigma} = \frac{-6.13\%}{8.974\%} = -0.6831$$

Bond Analysis

Bond information

Here is the information from Fidelity

Information	Name	
	UNITED STATES TREAS BDS	UNITED STATES TREAS NTS NOTE
Pay Frequency	SEMI-ANNUALLY	SEMI-ANNUALLY
Coupon	3.000	2.000
Maturity Date	02/15/2047	10/31/2022
Yield to Maturity	2.763%	2.064%

Duration and Convexity

The duration calculation can be completed by excel built-in function `DURATION`.

For the United States TREAS BDS, its duration is

```
= DURATION(DATE(2017,02,15), DATE(2047,02,15), 3%, 2.763%,
2) = 20.246
```

And for the United States TREAS NTS NOTE, its duration is

```
= DURATION(DATE(2017,10,31), DATE(2022,10,31), 2%, 2.064%,
2) = 4.783
```

Now for the Convexity, to make it simpler, I use the spread sheet from Stock Project 2 to finish this calculation. Here are some important steps and results.

$$D_1^* = \frac{D_1}{1+y_1} = \frac{20.246}{1.02763} = 19.701$$

$$\text{Convexity}_1 = \sum_{t=1}^{60} \frac{t}{2} \times (\frac{t}{2} + 0.5) w_t = 530.725$$

$$D_2^* = \frac{D_2}{1+y_2} = \frac{4.783}{1.02064} = 19.701$$

$$\text{Convexity}_2 = \sum_{t=1}^{10} \frac{t}{2} \times (\frac{t}{2} + 0.5) w_t = 25.911$$

Mutual fund recommendation

The following claims are all based on the information from Vanguard. The website has already marked the selected one. The reasons are (The Vanguard Group, Inc. N/A)

- Highly diversified, which helps spread out the overall risk.
- Huge size, about $10 billion for index funds and $5 billion for actively managed funds, which can be regard as a promise for lower risk.
- Reliable and Responsible, the fund managers are experienced and tenured, with a history of putting clients first.

Stock Mutual Fund

Back in China, one of the most astonishing findings during my project research is that sometimes just trading the small -cap stocks will result in a higher return than trading by a elaborately designed algorithm that may take you several days. The reason might be there're so many stocks that are underpriced so that with great probability that experience a booming period later. So based on this reason I would recommend Vanguard Small-Cap Index Fund Admiral Shares (VSMAX) (The Vanguard Group, Inc. N/A). It's expense ratio is 0.06% which is one of the lowest amongst several others. However it's return rates of three different time periods, 1 year, 5 years, 10 years, are all in the top positions of the overall stock mutual fund.

As listed on that page, its potential risk is in the highest level, meaning higher return and as for the fee, almost NONE! No purchase fee, redemption fee, or 12b-1 fee. Only when you meet some special requirements will you be charged $20 for account service fee.

Bond Mutual Fund

I would recommend Vanguard Total Bond Market Index Fund Admiral Shares (VBTLX) (The Vanguard Group, Inc. N/A). Its shinning points is its low expense ratio , which is just 0.05% and 93% lower than average expense ratio of funds with similar holdings. Also it's shown that it has a more attracting return rate. In terms of the long-term return like 5 years of 10 years, it performs pretty good as it ranks the forth position out of all the bond mutual funds. And it ranks the second when sorting the 1 year return rate in ascending order.

As for the fee, it's same with the one I just mentioned above.

Summary

This project contains almost all the materials taught this term except for the last two chapters on options. The major points are equity analysis, which focus on the relation of

individual stock and market performance using regression from Excel; portfolio analysis, which is designed for the relation of portfolio return and variance, or, Sharpe ratio; bond analysis, which mainly deals with bond pricing, duration and convexity, and several factors that can affect those; and the last one, mutual fund recommendation, which is basically about choosing the one you have faith with based on its price and performance, the risk and management, its fees and distributions. And doing this project is really helpful as a comprehensive review of all of the knowledge from the beginning of this semester. May all of them can stay in my brain forever.

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