PORTFOLIO PITCHDECK 2022 (US-SG EQUITY)

CAPITAL ASSET PRICING MODEL DEFINITION

Capital Asset Pricing Model gives us a formula to calculate the risk adjusted returns of an investment, factored in the market risks taken, represented by beta.

$$R_a = R_{rf} + \beta_a \times (R_m - R_{rf})$$

where:

R_a = Expected return on a security

R_{rf} = Risk-free rate

R_m = Expected return of the market

β_a = The beta of the security

$(R_m - R_{rf})$ = Equity market premium

With the definitions in place, let's look these baskets of stocks, from which we will select to form our 3 portfolios.

- AAPL (Apple Inc)
- TSLA (Tesla, Inc.)
- FB (Meta Platforms, Inc.)
- D05.SI (DBS Group Holdings Ltd)
- CTXS (Citrix Systems, Inc.)
- BX (Blackstone Inc.)
- VRSN (Verisign)
- CROX (Crocs, Inc)
- NKE (Nike)
- SBUX (Starbucks)

We will select from these stocks to form 3 portfolios.

A) **High-risk, High return**
B) **Medium-risk, Medium return**
C) **Lower risk, Lower return portfolio**

The basis of our selection will be on risks, which is represented by beta AND risk adjusted returns, which will be calculated using our CAPM model.

I) BETA COMPONENT

Beta is the correlation between performance of an asset versus a chosen benchmark. If a stock with beta = 1, means with benchmark move up 10%, the value of that stock will also increase 10%.

Beta is generally considered as a measurement of systematic risk for an investment.

The higher the beta, the higher the volatility of the stock in comparison to the market benchmark. This is also simplified as the popular term “high risk high returns”.

Beta can be calculated based on this formula

$$\text{Beta} = \frac{\text{Covariance}}{\text{Variance}}$$

where:

Covariance = Measure of a stock’s return relative to that of the market

Variance = Measure of how the market moves relative to its mean

Firstly, let’s calculate the beta of this basket of stocks.

Of course, the appropriate benchmark must be selected, for example for US equities market, we will use market-wide S&P500 index (GSPC) performance as our benchmark and Strait Time Index (STI) for Singapore stock.

We will use yahoo finance to download the daily Adjusted Close value of data, for the last 2 years, since 22/03/2022 to current in our analysis

Below is the snippet of numpy code which we use to calculate the covariance of individual stock’s performance against the market benchmark and the variance of that benchmark index relative to its mean.

In [19]:
```
tickers = ['AAPL', 'TSLA' , 'FB' ,'CTXS' , 'BX' , 'VRSN' , 'CROX' , 'NKE', 'SBUX', '^GSPC']
start = '2020-03-22'
end = '2022-06-12'

data = yf.download(tickers, start , end , interval="1d")

data = data['Adj Close']

log_returns = np.log(data/data.shift())

cov = log_returns.cov()
var = log_returns['^GSPC'].var()

aapl_beta = cov.loc['AAPL', '^GSPC']/var
```

We can repeat the same numpy code for all the stocks in our baskets to get the beta of all the stocks.

For DBS, we can use the same numpy code, but applying on benchmark which is Singapore Strait Time Index : STI (^STI)

We will arrive at the following beta measures

	Name	Beta
6	CROX	1.829023
1	TSLA	1.642472
4	BX	1.400768
2	FB	1.357159
9	DBS	1.252431
0	AAPL	1.205478
8	SBUX	1.141357
7	NIKE	1.070720
5	VRSN	0.931137
3	CTXS	0.474827

By this sorted list, we can see that some of these stocks like CROX (Crocs, Inc) or TSLA (Tesla, Inc.) are very volatile, and risky performance. But does “high risks” always equal to “high returns”, as the popular term?

II) SHARPE RATIO COMPONENT

Now with just Beta alone, it only measures how risky is the stocks. Higher beta does not necessarily mean better choices of investment. One must take into consideration the returns of that stock. One measurement for risk and stock returns, is Sharpe Ratio.

$$\text{Sharpe Ratio} = \frac{(rx - Rf)}{\text{StdDev}(x)}$$

Here are the individual components:

x = the investment
rx = the average rate of return
Rf = the best available rate of return of a risk-free security
StdDev = the standard deviation of the return

Essentially Sharpe ratio removes risk-free returns from the return of that stock. Therefore, investors can better isolate the excess returns that is associated with risk-taking activities. Whether the overall return is adequately compensating investors by taking more risks.

The higher the Sharpe ratio, the better is the stock performance, compared against its peer who are taking the same level of risks.

Risk-free returns mean the basic returns one individual can get even when he is not taking on any additional risks on his investment. One can put his money under the mattress, it is very

liquid and safe, but not generating any returns. Risk-free return is usually represented by the yield on government's bonds.

Among our baskets consists of stocks that are listed on US and Singapore exchanges. Economically speaking, these 2 countries are well developed countries with high credit rating. Hence one can be safe to assume that their government's bonds are as safe as any government's bond can be.

For US stocks, we will calculate Sharpe ratio with yield of US treasury 10 years bond 3.15% p.a
For Singapore stock, we will calculate Sharpe ratio based on yield of Singapore 10 years bond = 2.93% p.a

First, we create a dataframe for individual stock movement during that period above

```
aapl_df = yf.download('AAPL',
                      start,
                      end,
                      progress=False)

aapl_df = aapl_df.reset_index(level=0)
aapl = aapl_df['Adj Close']
```

We will use the below snippet of numpy code to create a function to calculate Sharpe ratio.
We will calculate the daily performance of the stock (comparing daily how much percentage of the stock has moved up or down)
From there, get the means and standard deviation of all these daily changes. We calculate the average daily sharpe ratio of the stock, and convert to annually by using 252 days (average numbers of trading days in the markets)

```
def sharpe_ratio (data, rf):
    daily_return = data.pct_change()
    daily_mean =np.mean(daily_return)
    sd = np.std(daily_return)
    daily_sharpe_ratio = (daily_mean  - rf ) / sd
    sharpe = 252**(1/2) * daily_sharpe_ratio
    return sharpe

aapl_sharpe = sharpe_ratio (aapl , rf)
```

Daily Rf (risk-free return) for US stock = 3.15% / 365 days
Daily Rf for Singapore stock = 2.93% / 365 days

We will get the below table of Sharpe ratio of our baskets of stock

	Name	Beta	Sharpe
1	TSLA	1.642472	1.684854
4	BX	1.400768	1.465571
9	DBS	1.252431	1.449649
0	AAPL	1.205478	1.330555
6	CROX	1.829023	1.294819
7	NIKE	1.070720	0.926738
8	SBUX	1.141357	0.558302
2	FB	1.357159	0.349803
5	VRSN	0.931137	0.243137
3	CTXS	0.474827	-0.167577

Notice there are some changes. High beta stock like Crocs Inc. and Meta (FB) are riskier by the measurement of their beta, but Sharpe ratio shows that their investors are not well compensated for taking such level of risks.

On the contrary, stock like DBS Group Holdings , AAPL (Apple Inc) may not be as volatile as Crocs or Meta, but their Sharpe ratio turned out to be better. This means their investors are being compensated more adequately (more excess returns) on the risk that they are taking.

III) CAPM: Risk adjusted Return

We have beta and we have Sharpe ratio of each of the stocks in our basket.

Based on the formula, which were stated at the beginning of this report, we will calculate what is the risk adjusted returns of our basket of stocks.

Similarly, as what we have done with individual stocks, we will calculate the average returns of the 2 benchmarks S&P500 and STI

```
sp500_df = yf.download('^GSPC',
                       start,
                       end,
                       progress=False)
sp500_df = sp500_df.reset_index(level=0)
sp500 = sp500_df['Adj Close']
sp500_daily_return = sp500.pct_change()

market_return = sp500_daily_return.mean()*252
print (market_return)

sti_df = yf.download('^STI',
                       start,
                       end,
                       progress=False)
sti_df = sti_df.reset_index(level=0)
sti = sti_df['Adj Close']
sti_daily_return = sti.pct_change()

sti_return = sti_daily_return.mean()*252
print (sti_return)
```

This is the Return of the Mark (Rm) component of the CAPM formula. Now we can produce the risk returned returns on each of the stocks in our basket over the last 2 years

	Name	Beta	Sharpe	Risk Adjusted Return
6	CROX	1.829023	1.294819	0.497770
1	TSLA	1.642472	1.684854	0.447009
4	BX	1.400768	1.465571	0.381241
2	FB	1.357159	0.349803	0.369374
0	AAPL	1.205478	1.330555	0.328102
8	SBUX	1.141357	0.558302	0.310654
7	NIKE	1.070720	0.926738	0.291434
5	VRSN	0.931137	0.243137	0.253453
9	DBS	1.252431	1.449649	0.215590
3	CTXS	0.474827	-0.167577	0.129289

We can see that our CAPM model returns ranking are quite similar to our ranking of Beta table, because Beta component is one of big component of the CAPM model.
We can also observe DBS (the Singapore stock) is ranking 5th among Beta table, yet its risk adjusted returns fall to 9th place. One reason is the risk free returns on CAPM for Singapore stock is 2.93%, compared to US market risk free return of 3.15%.

II) PORTFOLIO SELECTION

A) HIGH-RISK / HIGH RETURN PORTFOLIO

Risk can be measured by Beta and Returns can be measured by Risk adjusted return.
Based on this, we can pick 3 stocks from our baskets to form this portfolio.

- CROX (Crocs, Inc)
- TSLA (Tesla, Inc.)
- BX (Blackstone Inc.)

Crocs Inc. is American brand that manufactures and distributes footwear and fashion accessories for public. Its signature product is the line of footwear combination of sandals + slides.

Its product and the brand name are so renown to the level where the name of the company “Crocs” have essentially became a part of English vocabularies(other example is google). The word “crocs” have become the definition for this design of sandals, regardless of whether the sandals are produced by the company or not.

Crocs Inc. is a global brand, which are distributed over 85 markets and countries around the world, across every continent. Being relatively young company, their success in over-saturated fashion industry is quite remarkable.
The quality of their products is quite noticeable. They are made by a proprietary material called foamable EVA (ethylene-vinyl acetate) which expands in a mould. This is also reason why the footwear is light and comfortable. The material would also conform to the feet of their customers, which enhance a higher level of personalized experience to the wearers.
The distinct design (various holes around the footwear) is also to allow feet to breath and drain water easily, making it an ideal pair of casual wear.

But the most important part of Crocs success is not just the quality or design of their products, but rather, the genius marketing behind. Crocs sandals used to be labelled as the “uncool”, “cheap” and “ugly” due to the distinct design with various holes in its bodies. But the genius behind Crocs marketing have fully embraced these labels, as the saying goes **“**There are no such thing as bad publicity**”.**

Instead of conforming to industry norm and changing their designs, they continue to pursue the marketing campaign along with this design. As younger generation started to embrace the “uncool” and the difference from the social norm, Crocs represents the rebellious “fashion statements” and the “I am comfortable with who I am” for the younger generations, the value of their brand started to skyrocket. Crocs marketing team also collaborate with various younger music stars, models, and sport stars, which further spread the marketing images across the younger generations.

With the highest Beta and highest Risk-adjusted returns in our basket, Crocs has both the volatility and the returns to fit our high-risk portfolio,

Tesla Inc. is the manufacturer and the global pioneer in the field of electric vehicles. Its CEO, Elon Musk, is the richest billionaire in the world, he is a controversial figure that is as famous as any celebrities, controversial not only in term of his profiles, but also his statements and actions.

His Twitter account has the power to influence prices on the stock markets and cryptocurrencies markets with such magnitudes that no individual has ever possessed before since the age of Internet begins.

Tesla Inc., like its CEO, is also a controversial company. One of the first auto-manufacturers that managed to produce a commercial electric vehicle, which sparks a global race to electric vehicles technology and products.

Various startups from China and US like Nio or Lucid race to produce their own commercial electric vehicle models and aspire to grab the lion-share of the future of auto-industry. Meanwhile the existing auto-manufacturers, like FORD, TOYOTA, Volkswagen, Mercedes felt the fear of being outdated by new EV companies and quickly push to develop their own electric vehicles to enter the race.

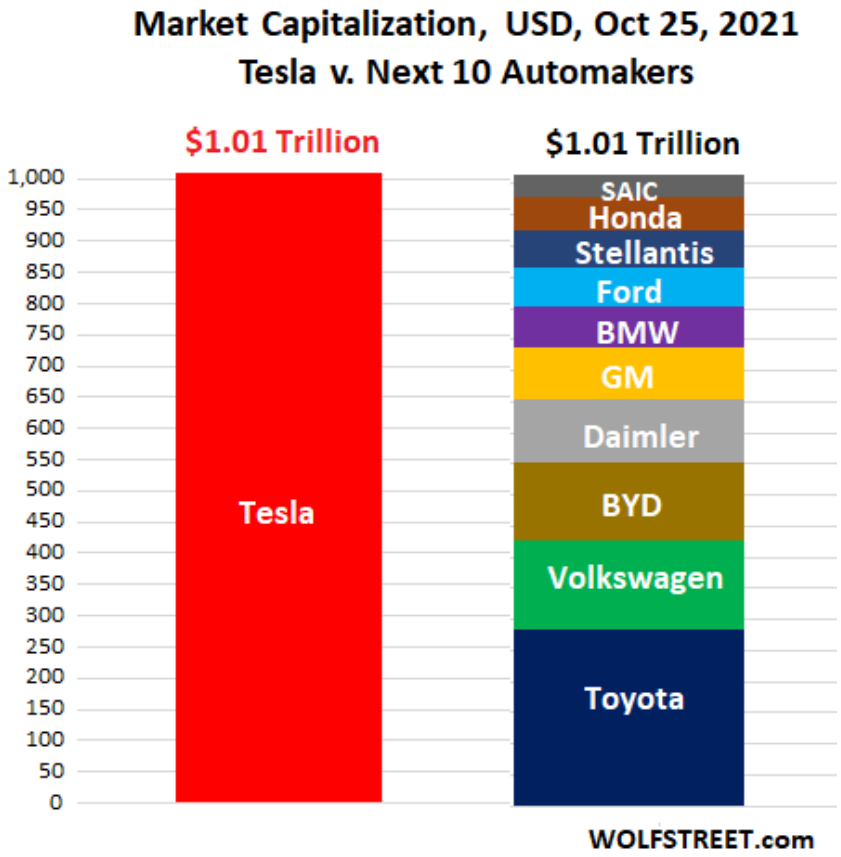
But none of these companies hold the first mover advantage like Tesla and Elon Musk. Tesla boast of superior technology of electric vehicle engines, its proprietary electric battery and the brand value of Tesla are the results of years of research, developments, and cultivation by

Tesla teams. Years ahead of its competitors, not only in term of hardware technology but also software technology. One could say Tesla vehicle is the first “Iphone” of the auto-industry, the same way as Steve Job’s Iphone has changed the handphone industry forever.

Historically Tesla stock had been the target of short-sellers in the market for many years. Its cost of R&D was astronomically high and its financial were suffering for many years. But as public has become more alerted to pollutions and environment impacts of fossil fuels, Tesla EV has found its foothold in the American auto-industry and the stock has become the darling of market. Valuation has been skyrocketed and made Elon the richest man on earth.

One would say Tesla is currently overvalued, if we were to look at the number of vehicles sold.

In 2021, Tesla delivery is only approx. 1 million vehicles, a very small number compared to any traditional auto-industry manufacturers, for example Japanese automaker Honda sold 4.5 million units in 2021. Yet Tesla valuation alone equals the next 10 largest automakers valuation COMBINED.



This explains why the Beta of the Tsla Inc. stock is so high, its price is very volatile and outperform the market benchmark hugely for the last 2 years. Whether it is a truly a unicorn or just an unsubstantiated effect of Elon’s influence on market, only the future knows. But we can conclude it deserves to be a part of our high-risk portfolio.

BX Blackstone Inc. is an asset management corporation, that provides their services in every aspects of financial services. One of the most diversified companies in the world, it has its tentacles in every pies of investments: real estates, commodities, hedge funds, private equities, mutual funds, ETFs, debt and equities etc… If there is an investment opportunity on earth, you can be sure that Blackstone or its subsidiaries would be one of the biggest

participants in that market and more than that, they are often most influential that can impact the entire market.

By being so diversified in their revenue streams, one can say it is very difficult to valuate Blackstone. Is it an investment bank? An advisory firm? A trader? Or a tech company? Being diversified would allow it to be well insulated against specific industry effects or market recessions. Especially with the recent development of macros around the world, where central banks started quantitative tightening and increased bank interest rates, the era of cheap cash, low interest debt is disappearing, and investors start to look for alternative safe havens to divert their money,

Blackstone holds an enormous advantage over other stocks in our baskets, where others are usually fully committed to one industry that can be negatively affected if global investors decide to avoid that industry.

Based on its stock market prices performance and its beta in our calculation, we can safely assume it should be one of the most important components of our high return portfolio.

B) <u>Medium Risk / Medium Return</u>

- FB (Meta Platforms, Inc.)
- AAPL (Apple Inc)
- DBS Group Holdings

FB (Meta Inc.) is one of most successful unicorns of Silicon Valley. Facebook has not only changed the human lifestyle, but also altered the very landscape of human communication and interactions. Facebook has the number of users at 2.93 billions, and this is just the official numbers. Facebook is how modern human connect and make friends, how human keep track of their friends and interact with each other activities. Not only that, their other products, Instagram is also one the most popular social networks, and Whatssap has replaced phone messaging as the primary form of texting and communication.

The biggest and most pervasive company in history of human race, FB possess the unquantifiable amount of data on billions of users, their preferences, their personalities, their tendencies, their political spectrums etc… If there are a technology to replicate a human, then FB would be the company that replicate that person's memories, experiences based on the data in its possession.

And of course, Facebook is good at monetize these data through target advertisements. Human life has become a lot more convenient, when the product which you need, will be advertised directly for your perusal, almost instantly.

But recent years see Facebook also facing various controversy concerning privacy infringement and its ability to alter political landscape and influence elections.

Facebook stock market price portrays its leadership in social network. It was trading at multiple much higher than its peer and easily outperform S&P500 benchmark over the last 2 years.

Valuation of tech industry stocks, FB included, are suffering huge downturn the recent 6 months with the macros condition of interest hike and shutting down of quantitative easing by US central bank. Many argues that the tech industry in general have been overvalued for the

last decade, and this downturn is correction needed to bring the valuation of the tech companies to a realistic level.

Whether tech industry leader Facebook would come crashing down or it would return to its previous high, that remains to be seen. But one can bet that Facebook high beta will allow the company to outperform the benchmark once again if the market recover from the upcoming recession.

FB Sharpe ratio is quite low compared to other stocks in our basket, that means returns is relatively lower compared our previous 3 choices. That is reason why we decide to place FB a as part of our 2nd portfolio : Medium Returns

AAPL (Apple Inc.) is the manufacturer of electronic devices: smartphone, tablets, computers etc… The largest company in the US, with the market capitalization of 2.5 trillions USD. Apple products literally reshaped the technology landscape of human daily lives. In 2007 when first Iphone launched, Nokia, Sony and many other titans were the top of personal handphones market. However within a decade, Iphone sparked a smartphone race, that completely obliterated old handphone manufacturers.

Apple products are years ahead of competitors in term of technology, its operating system is one of a kind, IOS that also started the trend of digital ecosystem where users can link all their smart devices and data. Their product designs are modern, simple yet unique. Moreover, they truly focus on customers experience to spark the market leading trends: eg: facial recognition, fingerprint login, lagless and smooth design, and many different features.

Not only in term of the technology, Apple has cultivated a powerful brand image, that links the company with innovation and Silicon Valley titan. An extreme strong and loyal customer fanbases, with hundreds of millions of followers.

Not only that, Apple management, unlike some startup unicorns, are extremely focused on financial sides of the company. It maintains a healthy profit margin, growing revenues steadily over the last decade. Company has a healthy debt / equity ratio at 56% in 2021, and as per Apple 2021 financial report, it is holding on its balance sheet $172.6 billions of cash and cash equivalents.

Apple has the steady growth of tech unicorn, and healthy balance sheet better than a bank. The brand names, the customers loyalty and its various ventures into many different areas, including electric vehicles, financial technology, AI development etc… ensure the company is indeed one of the best investments in the world.

Our calculation returns that Apple Beta is at 1.20 , not as high as other stocks in High Risk portfolio, would mean it belongs to the medium risk portfolio. But Apple investor can be assured that lack of volatility in Apple stock is actually positive point. The company is fundamentally strong and well balanced to weather any upcoming recessions.

DBS Group Holdings is the only bank stock in our basket. Development Bank of Singapore is the largest local bank in Singapore, the centre of Asia Pacific financial market and technology hub. It is a traditional bank that offer full banking services from retail to institutional clients. It also offers corporate banking advisory services, sell-sides analytics, capital market financing solutions to both banks and nonbank financial institutions, to governments and other SMEs clients. Its reach does not limit in Singapore small population but rather grew with Singapore over 4 decades of development of country from third world economy to one of the most developed country in the world.

DBS now operates all over Asia Pacific, Greater China and Hong Kong and one of the few non-US/UK banks that can expand into South Asia regions to tap into India market. A true powerhouse of financial institution.

With the MAS (Singapore central bank) strict oversight and Singapore transparent and supportive regulations, DBS is fundamentally strong, a stable operating profit margin and dividend yield. As per Fitch rating (DBS FITCH RATING. (2022), last year 2021 despite the covid-19 impact on economy, DBS still maintains 408 billions of loans portfolio on its total assets of 686 billions (Loan / Total Asset = 60%) , yet its nonperforming loans was still at 1.6%, relatively low.

Despite its strong position, DBS management is very forwarding looking. They recognize the threat of fintech startup and digital banks emerge. DBS management have invested heavily to cultivate a new image for the bank, attract tech talents and push to rebrand the bank as a tech company rather than a brick-and-mortar bank. They are one of the first banks in the region to start various infrastructure to assist local and regional startups companies by setting up incubators and accelerators. DBS and its subsidiaries in China, Hong Kong and India are actively collaborating with partners in respective markets to roll out different incubation and seed-financing programs for local startups and fintech.

DBS 2 years of historical data portrayed a strong Beta number and even 3rd best Sharpe ratio among other stocks in our basket. Investors should keep in mind, that DBS numbers are compared against Singapore market, which is relatively less volatile than US market, making their Beta and Sharpe ratio more impressive.

Despite DBS ranking quite low on our calculation on Risk Adjusted Return, there are 2 reasons why DBS belongs in the Medium portfolio.

First of all, DBS risk adjusted return based on stock market movement of prices, do not include dividend yield, roughly and stable between 2.5%-3% p.a .

Secondly, US Federal reserve has triggered the hike of interest and fully committed to control inflation in US, at the cost of US equities market downfall. Together with US central bank, central bankers and every major economies in the world have also switched to use measures of quantitative tightening and increase their own interest rates. This will directly bring in more profit for DBS as bank with a heathy loan portfolio and low nonperforming loans ratio. This will also signify certain capital flights from US and Singapore blue chips stock like DBS, can be the one of the destinations.

C) <u>Low Risk / Low Return</u>

- Starbuck (SBUX)
- NKE (Nike)
- VRSN (Verisign)

Starbuck (SBUX) is the marketer and retailer of coffee worldwide. It operates worldwide, through either licensed stores or grocery and foodservices. Many coffee connoisseurs do not like Starbuck and may have the opinion that Starbuck provides subpar quality coffees at premium prices. However, they miss the point of Starbuck business models. While Starbuck may appear to be a coffee store, Starbuck is actually a fast food brand. They do not compete for highest quality beans to satisfy the coffee experts, they are focusing on providing high-end café quality at cheaper prices, compared to an actual high-end café. Their products are consistent, across global chains. This appeal to mass market, same way as fastfood chains does. They also expanded aggressively since 2000s, which they would take out local competitions by setting franchise / stores over all heavy metropolitans.

Starbuck popularity also explodes with the younger generations when they were the first few coffee brands that offer wide variety of different caffeinated sugar beverages, rather than just black coffees (expresso) or sugar/milk traditional coffees drinks.

Accessibility, Affordability and Consistency, Starbuck is a McDonald of the coffee world.

From our model, Starbuck has beta of 1.14, which is lower than stocks in our 2 previous portfolios, lower beta means their stock would track closer to the benchmark performance. However while Starbuck is a beverage fastfood chain that has global presence, its growth prospect seem bleak, as there are much more competitions in the beverage business.

Hence it is our addition to the low risk and low return portfolio. It may not have explosive growth but it is a safe investment, at least for the near future.

NKE (Nike) is a fashion brand that designs, produces, and distributes athletic footwear, apparels and sport equipment. If Crocs is the new kid on the footwear block, then Nike is the grandfather of the sportwear brand. Nike is the largest sportwear company in the world, with the current market capitalization of USD$169 billion (its brand NIKE alone is worth 33 billions, as per Statisca). Their closest competition is Addidas, which has current market capitalization of USD$30 billions.

Nike is one of the most recognized brand in the world. And similar to Apple, it is able to command premium prices for its products. Financial-wise, as per Nike financial reports, their earning and cashflow have been steady for decades. But unlike Crocs, Nike is a matured company, with less growth prospect. Hence their share prices reflected that. Their share price is not as volatile as other stocks in our basket.

Our model generated beta for Nike nearly 1.0, which means Nike performs very closely versus our benchmark, the S&P500 index. Its adjusted return is also among the lower rank in our model. Nike is a matured bluechip, low beta and would fit perfect in low volatility portfolio.

VRSN (Verisign) is an interesting company. It is one of the few companies that majority of people use their services, without realizing it. It is the global provider of domain name registry services and Internet infrastructure. The management prided themselves as an important support for Internet 2.0. They provide registration services for .com and .net top level domains, which are most websites on the Internet. Not only .com and .net, the company also operates authoritative directory of backend system for most of other popular domain names: .gov , .edu etc… In layman term, Verisign services allows individuals and entities to establish online identities.

That's why Verisign is unexpectedly, one of the largest companies in its field. It is also one of the pre-dotcom bubble internet companies that still survive til present day. That's why it is a matured company with stable operating margin and with little competitions for their main services.

With their 2nd lowest beta in our basket, slightly below 1.0, Verisign tracks benchmark very close with less volatility, yet provides risk adjusted return on almost the same with Nike.

That's the reason why we should consider adding VRSN in our low volatility portfolio

III) PORTFOLIO PROJECTION

(Author's Note: Monte Carlo simulation is random generations based on derivatives of the existing data, using np.random, hence every time Jupyter notebook is run, the numbers and the simulation results may be different from what is written on this report. Please consider these as reference in the context of this report only)

We will assign USD$1000 each per positions for each stock. Therefore each portfolio, the initial value of the portfolio will be USD$3000

We will use Monte Carlo simulation to project how each portfolio would perform, 100 days into the future.

First, we have to create our 3 portfolios as per below

```
high_portfolio = pd.DataFrame({'Crox': crox ,'Tsla': tsla, 'Blackstone' : bx})
high_ticker = ['Crox' , 'Tsla'  , 'Blackstone']

medium_port = pd.DataFrame({'FB': fb ,'AAPL': aapl, 'DBS' : dbs})
medium_ticker = ['FB' , 'AAPL' , 'DBS']

low_port = pd.DataFrame({ 'SBUX': sbux, 'NKE' : nke , 'VRSN' : vrsn})
low_ticker = ['SBUX' , 'NKE'  , 'VRSN']
```

We need to calculate the daily returns of each portfolio and with the initial value of $1000 per position, we will calculate how each portfolio performs over the last 2 years. We can do these actions with the function below.

```
def portfolio_data(dataframe, tickers):
    portfolio_daily_change = dataframe.pct_change()
    portfolio_daily_change = portfolio_daily_change.replace(np.nan, 0)
    portfolio_daily_change += 1

    temporary = []
    a= 1000
    for i in range(len(portfolio_daily_change)):
        a = portfolio_daily_change.iloc[i]*a
        temporary.append(a)
    portfolio_total_return = pd.DataFrame(temporary)
    portfolio_total_return['Daily Value'] = portfolio_total_return[tickers].sum(axis = 1)

    return portfolio_total_return
```

```
high_portfolio_df = portfolio_data (high_portfolio, high_ticker )
medium_portfolio_df = portfolio_data (medium_port, medium_ticker )
low_portfolio_df = portfolio_data(low_port, low_ticker )
```

The results would be a dataframe for each portfolio, over the last 2 years. Here is an example high_portfolio_df.head(10)

Crox	Tsla	Blackstone	Daily Value
1000.000000	1000.000000	1000.000000	3000.000000
1201.754365	1162.817449	1107.657914	3472.229729
1486.443337	1241.681784	1188.124233	3916.249353
1469.696999	1216.145913	1331.853227	4017.696139
1437.799102	1184.369887	1278.856629	3901.025617
1395.534295	1156.208991	1311.875365	3863.618650
1354.864420	1206.567052	1264.428127	3825.859599
1239.234450	1108.844258	1132.075174	3480.153883
1262.360444	1046.466594	1142.896579	3451.723617
1173.046259	1105.275242	1158.157496	3436.478997

As you can see day 0, all 3 sticks have value of $1000 each and total portfolio value of $3000.

With the daily value of the portfolio over the last 2 years, it’s time to run our Monte Carlo simulation.

```python
#MONTE CARLO SIMULATION
def monte_carlo( portfolio, days, futures):
    log_returns = np.log(1 + portfolio['Daily Value'].pct_change())
    mean = log_returns.mean()
    var = log_returns.var()
    drift = mean - (0.5 * var) #check drift
    stdev = log_returns.std()

    daily_returns = np.exp(drift + stdev * norm.ppf(np.random.rand(days, futures)))

    current_value = portfolio['Daily Value'].iloc[-1]

    simulation_result = np.zeros_like(daily_returns)
    simulation_result[0] = current_value
    for t in range(1, days):
        simulation_result[t] = simulation_result[t - 1] * daily_returns[t]

    simulation_result = pd.DataFrame(simulation_result)

    #from this part down is to draw the charts of all possible futures after last day of the dataframe


    current = portfolio['Daily Value']
    current = pd.DataFrame(current)
    full_picture = [current, simulation_result]
    monte_carlo_forecast = pd.concat(full_picture)
    monte_carlo = monte_carlo_forecast.iloc[:,:].values

    plt.figure(figsize=(20, 10))
    plt.plot(monte_carlo)


    plt.show()

    return simulation_result
```

HIGH PORTFOLO MONTE CARLO SIMULATION

```python
high_portfolio_forecast = monte_carlo(high_portfolio_df, 100,50)
```

Monte carlo is basically we will generate random values of the portfolio over the next 100 days, with 10 different futures.

We will calculate the daily percentage change of the existing portfolio, we calculate the mean and the standard deviation of the portfolio.

We will use drift as representation of random noise, which is calculated by

$$\text{Drift} = \text{Average Daily Return} - \frac{\text{Variance}}{2}$$

We then generate random daily returns by np.random, with a normal distribution (norm.ppf)

And we will take the last date of the existing portfolio as the beginning of the simulation result matrix

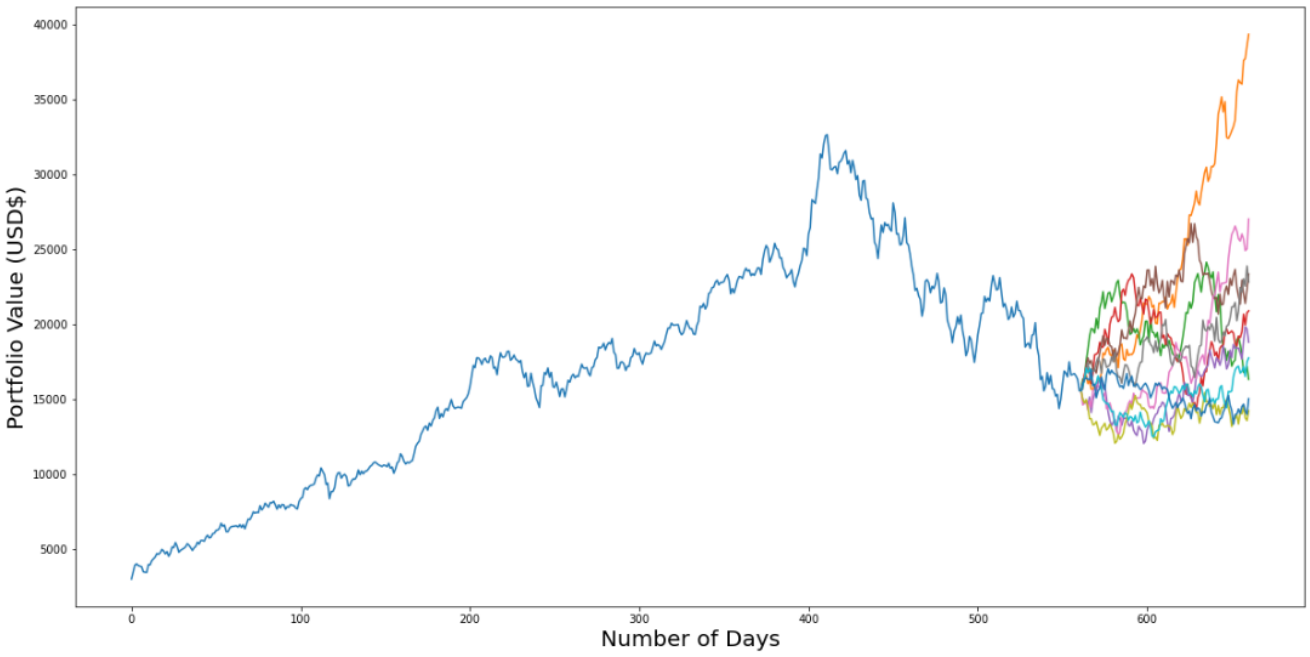
current_value = portfolio['Daily Value'].iloc[-1]

simulation_result[0] = current_value.

Use matplotlib to draw all the 10 possible futures.

HIGH PORTFOLO MONTE CARLO SIMULATION

```
In [37]: high_portfolio_forecast = monte_carlo(high_portfolio_df, 100,10)
```



The simulation result will be a matrix, 100x10, each cells represents a possible daily value of the portfolio, calculated based on forecasted daily_returns times previous day daily value.

This table is easier to understand

```
In [35]: high_portfolio_forecast.head(15)
```

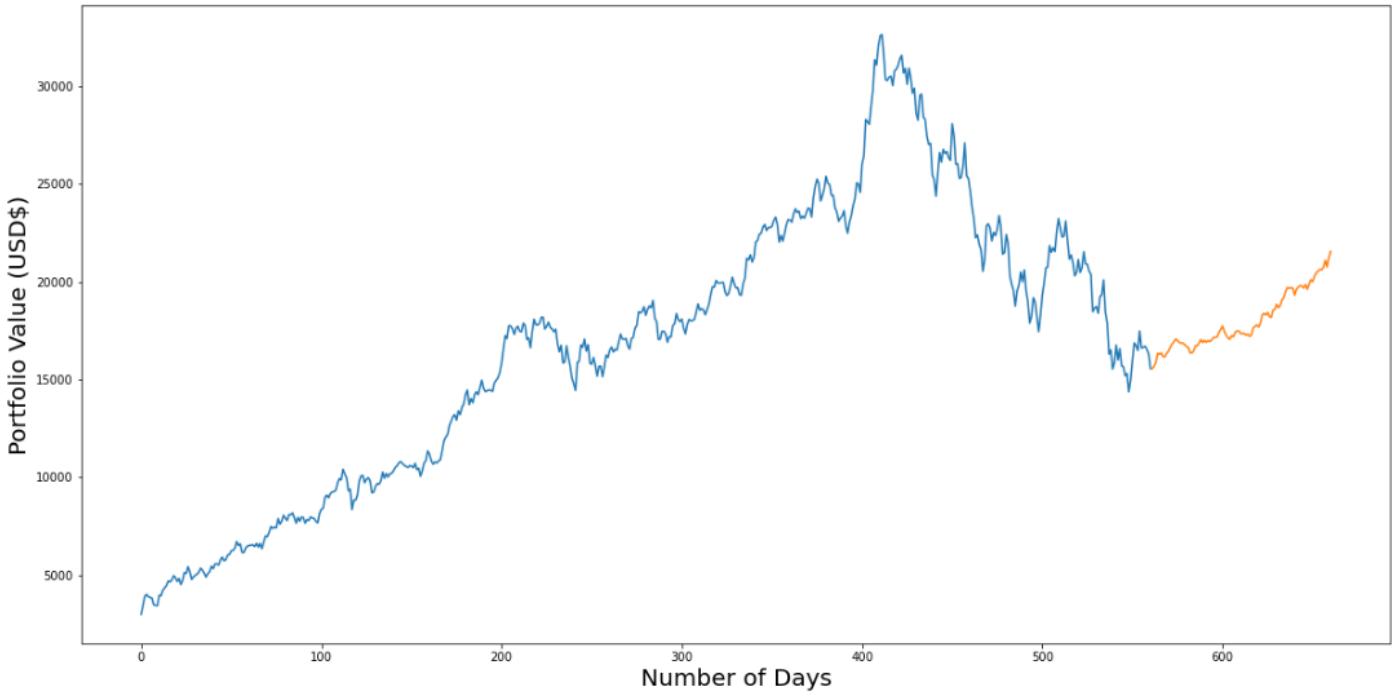
Out[35]:

	0	1	2	3	4	5	6	7	8	9	Forecaste Avg Dail Valu
0	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.535425	15559.53542
1	16172.732787	15569.977899	16513.666519	15513.823095	15270.662074	15382.848634	16301.994804	15829.894258	16043.572342	15164.607913	15776.37803
2	17127.113498	14900.326449	16356.182158	15409.816648	15792.125574	16071.048904	16299.698091	15706.499360	15890.295906	14598.977062	15815.20836
3	17855.408269	14566.696860	16967.064853	15042.147590	15867.752130	15524.249359	16037.009263	16732.985459	16202.878183	15964.648123	16076.08400
4	17472.992185	15221.150635	17345.307339	13951.747366	15275.038905	15296.065772	16448.529753	16387.391649	15953.898857	15361.263893	15871.33863
5	17599.370497	13986.154244	17015.669821	13690.316245	14806.580812	15950.900178	16128.228229	16214.877646	16275.110638	15674.148330	15734.13566
6	17569.110764	14671.977016	18145.683661	14182.071552	15555.355273	15650.571732	16322.578489	17149.356004	16447.699365	15937.464662	16163.18685
7	17660.122632	15235.670422	18203.731196	14242.890170	15867.425473	16277.700669	16485.929513	16904.867783	17145.448816	15470.241104	16349.40277
8	18168.139461	15104.194602	16841.959805	14333.291840	14797.771821	16515.537734	16015.335043	17100.617010	17247.299297	15519.937095	16164.40837
9	18900.900168	14811.959745	17492.328691	15006.118105	14983.920419	17159.377489	16003.828332	17309.853247	17080.134633	15336.774589	16408.51954
10	19151.943971	15011.553216	17390.991751	15395.461213	15177.446817	17982.391210	16028.741926	17919.372950	17552.796297	16100.119586	16771.08189
11	19560.536585	14265.688665	17478.653617	15908.814455	15228.792502	17816.889946	15480.633620	18761.611227	18356.086071	16327.799882	16918.55065
12	20070.469430	13284.503965	17324.415567	16439.135165	15685.039752	16933.388654	15537.012292	19731.530239	18153.457901	15536.927582	16869.58805
13	21069.484115	13009.176633	16931.257059	16308.222413	16526.936371	16520.551235	15998.606078	18841.817103	17685.876762	15879.976698	16877.19044
14	21381.641682	13083.761361	16884.957039	17375.606103	16631.474097	16635.060167	15632.397722	17790.540187	17484.695171	15700.935055	16860.10685

The row represents the day into the future. (in this is 15 days)

The 10 columns represent the 10 possible futures, the last column is the average of each day.

Let’s draft the average portfolio value for each day for the next 100 days.




```
Current Portfolio daily value is  15559.535425484935
Max avg Portfolio in next 100 days is 21548.841228328
Max avg Portfolio in next 100 days is 15559.535425484935
```

As of current, our high return portfolio has value of USD$15,559.53. Impressive if our initial investment was $3000 from beginning of the period 22/03/2020.

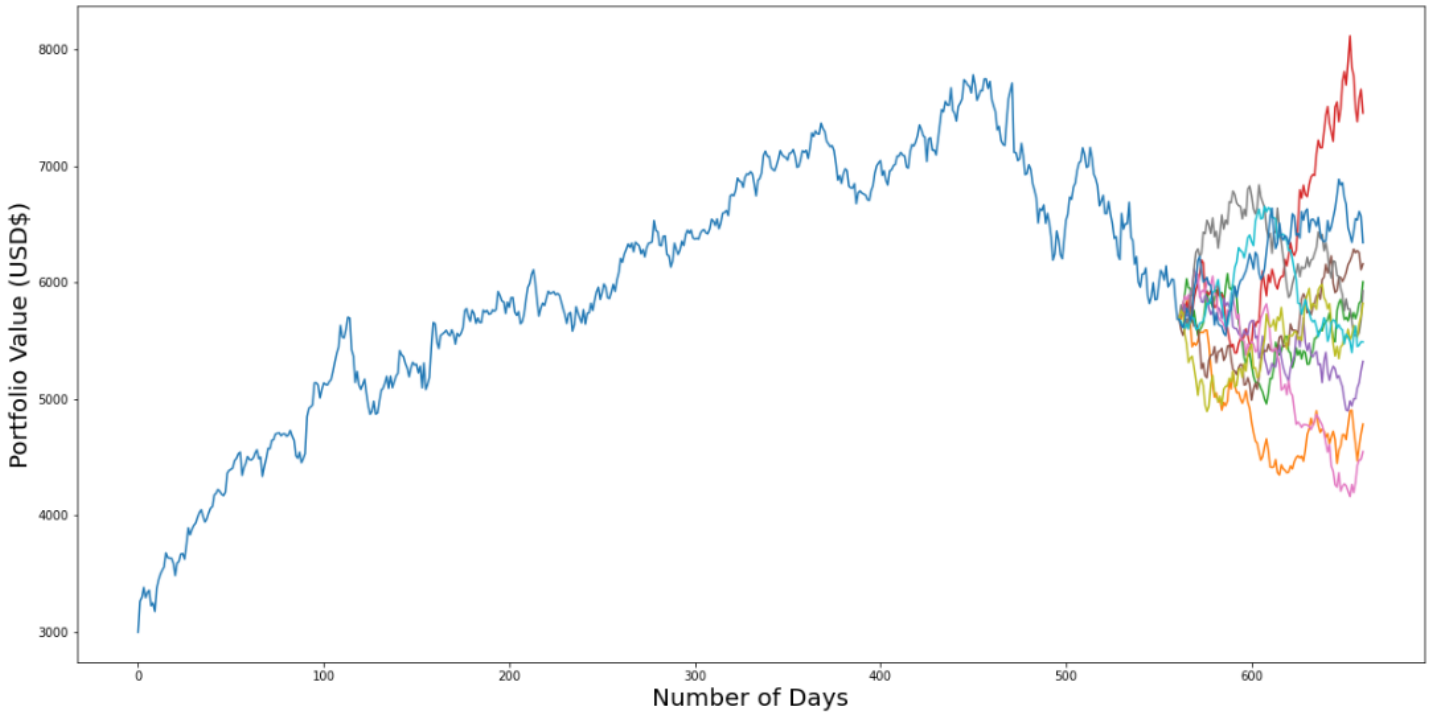
Over next 100 days, the maximum average value for the high risk, is US$21,548.84, if we

Minimum average portfolio for high risk portfolio is US$15,559.53. This indicates, that portfolio is on general uptrend from current day until 100 days later.

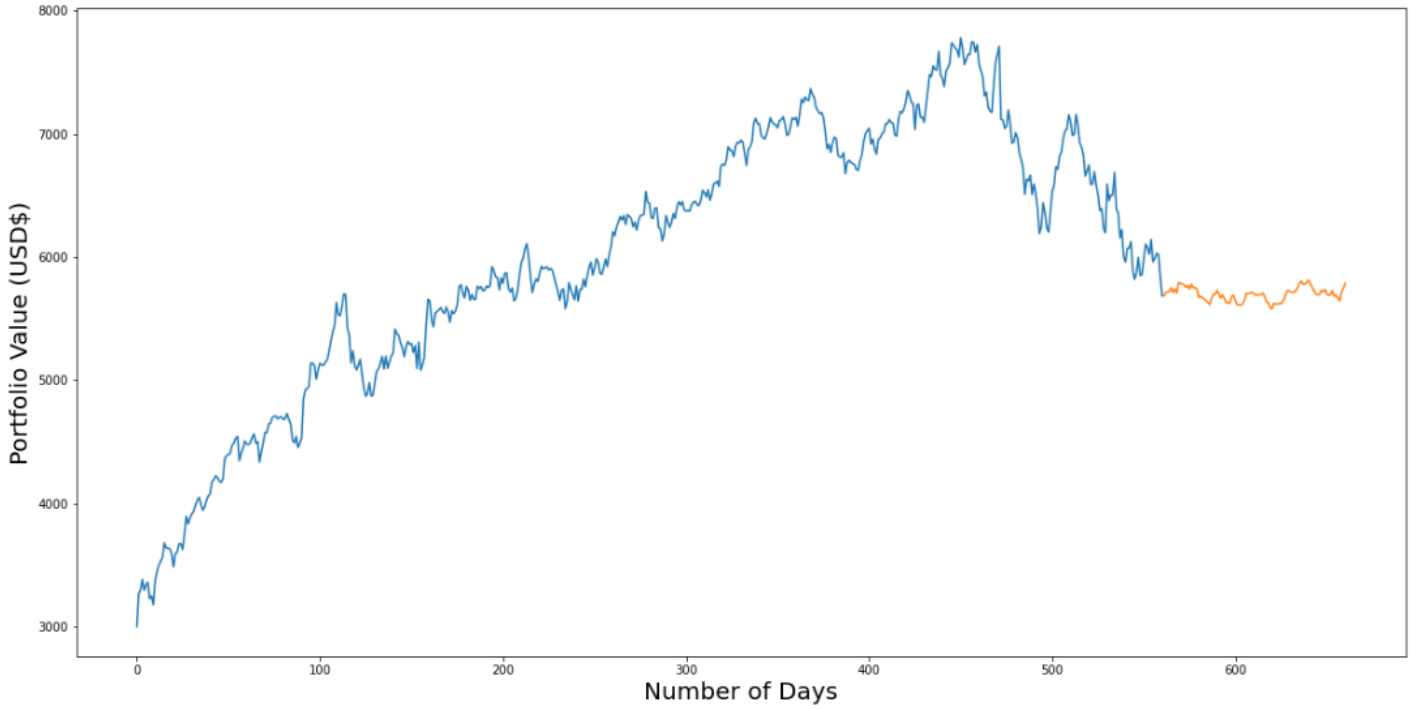
Before jumping into conclusion, let’s look at the remaining 2 portfolios.

MONTE CARLO SIMULATION ON MEDIUM RISK PORTFOLIO

```
medium_portfolio_forecast = monte_carlo(medium_portfolio_df, 100,10)
```



Monte Carlo simulation average of the daily values for Medium portfolio is




```
Current Portfolio daily value is  5684.017879640138
Max avg Portfolio in next 100 days is 5813.05847679437
Max avg Portfolio in next 100 days is 5580.224416853141
```

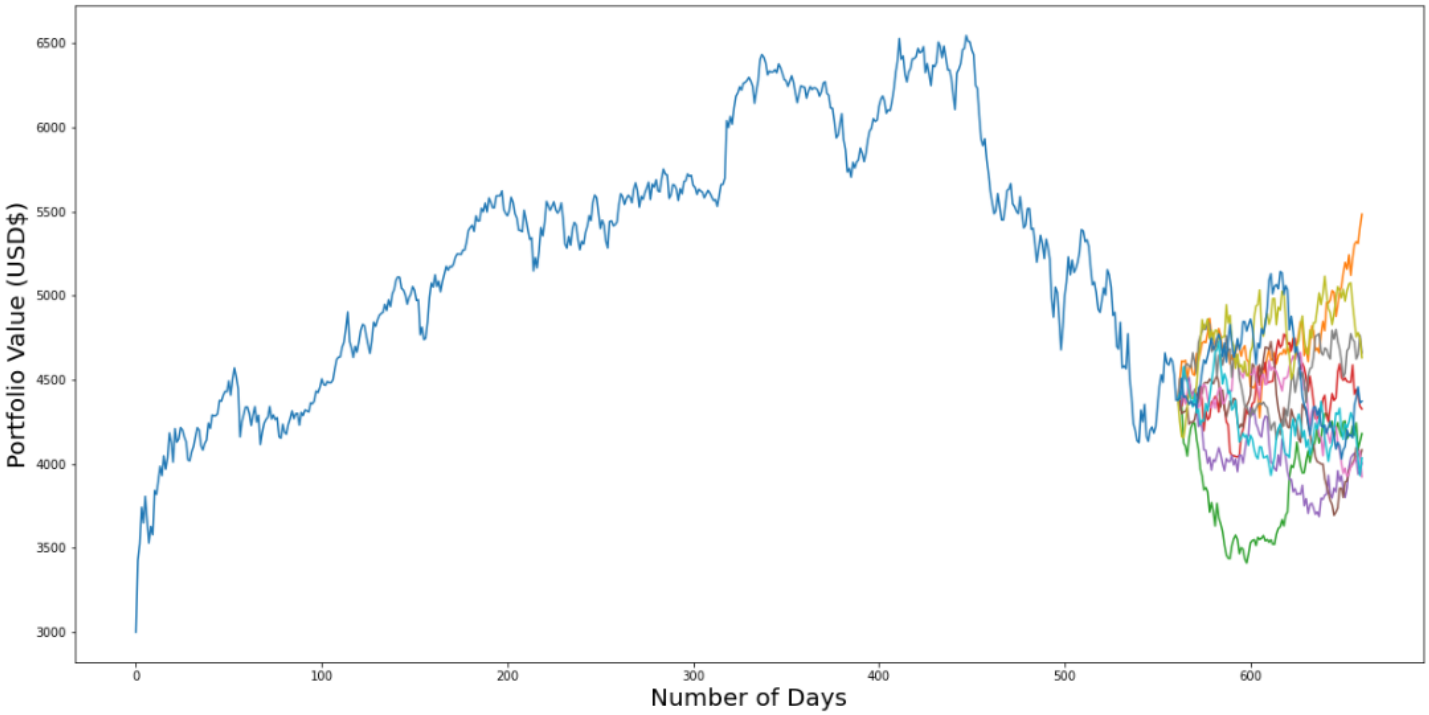
Our current value for medium portfolio is US$5684.01 from initial investment of US$3000

Yet over the next 100 days, maximum of Medium portfolio is $5813.05 while minimum is only $5580.224 (means we can actually lose the money)

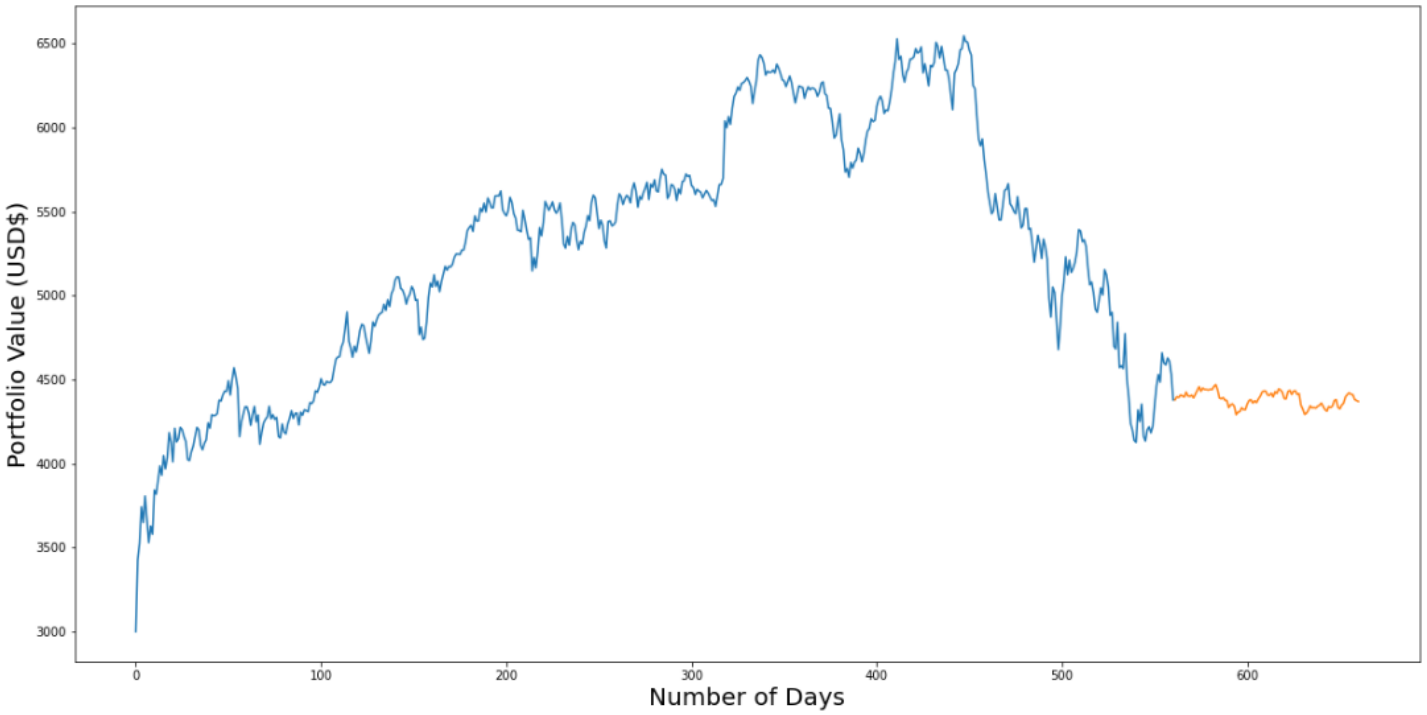
MONTE CARLO SIMULATION ON LOW RISK PORTFOLIO

LOW PORTFOLIO MONTE CARLO SIMULATION

```
low_portfolio_forecast = monte_carlo(low_portfolio_df, 100,10)
```



Monte Carlo simulation average of the daily values for Low portfolio is




```
Current Portfolio daily value is  4379.116187342202
Max avg Portfolio in next 100 days is 4469.706997125649
Min avg Portfolio in next 100 days is 4290.772869436042
```

Current portfolio value is US$4,379.11, still up from initial investment of $3000

However, similar to Medium portfolio, the Low portfolio highest possible value is $4,469, barely increases from our current value. While investors can actually lose money if Minimum situation happens.

IV) Analytics and Explanation

Based on the 3 simulations above, it seems like investors should definitely choose to pick the high risk high return portfolio, because even in its lowest possible average, it still yields the best possible returns among the 3 portfolios.

However, there is a biasness in data, which cannot be ignored.

Monte Carlo simulation is random generation, however results are still generated based on **derivatives** from our existing data**: drifts, means, standard deviations**. Since we picked the beginning of our period as 20/03/2022, this has skewed the data

This is because from our beginning period 22/03/2020, market has been on general upward trend, (22/03 was the end of the Covid market crash), after 22/03/20 until December 2021,, market has been on an absolute bull runs.

Hence the stocks in high risk (high beta) portfolio have benefited much more than other portfolios, which makes the Monte Simulation result is also on general uptrend.

The standard deviation for the high portfolio 10 days simulation is 1466.14

The standard deviation for the medium portfolio 10 days simulation is 53.72

The standard deviation for the low portfolio 10 days simulation is 43.57

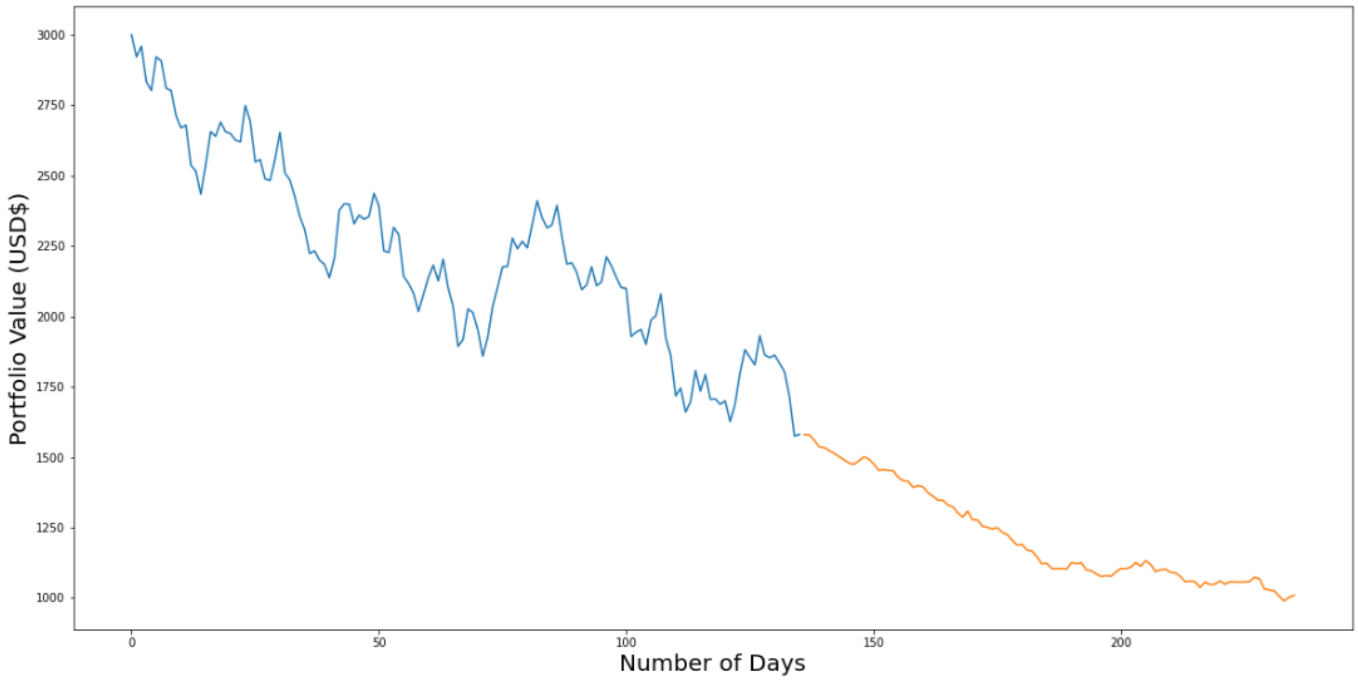
This means for the high portfolio, the daily performance hugely varied from the means of the portfolio, and this may not be a good thing if the entire market is in different scenario.

For example, from the beginning of the 2022, Federal Reserve has been adamant on controlling inflation, by raising interest rates aggressively, and started quantitative tightening, this has affected stock market negatively and it seemed like the bull runs which investors have enjoyed over the last 2 years, have disappeared.

Together with other macro events, for example, Ukraine Invasion which sparked huge increase in oil price and disrupted the supply chains of many different products and commodities, 2022 has only been barrage of bad news and uncertainty for the stock markets.

Let’s what happens if we pick the start date of from beginning of downtrend. 01/12/2021

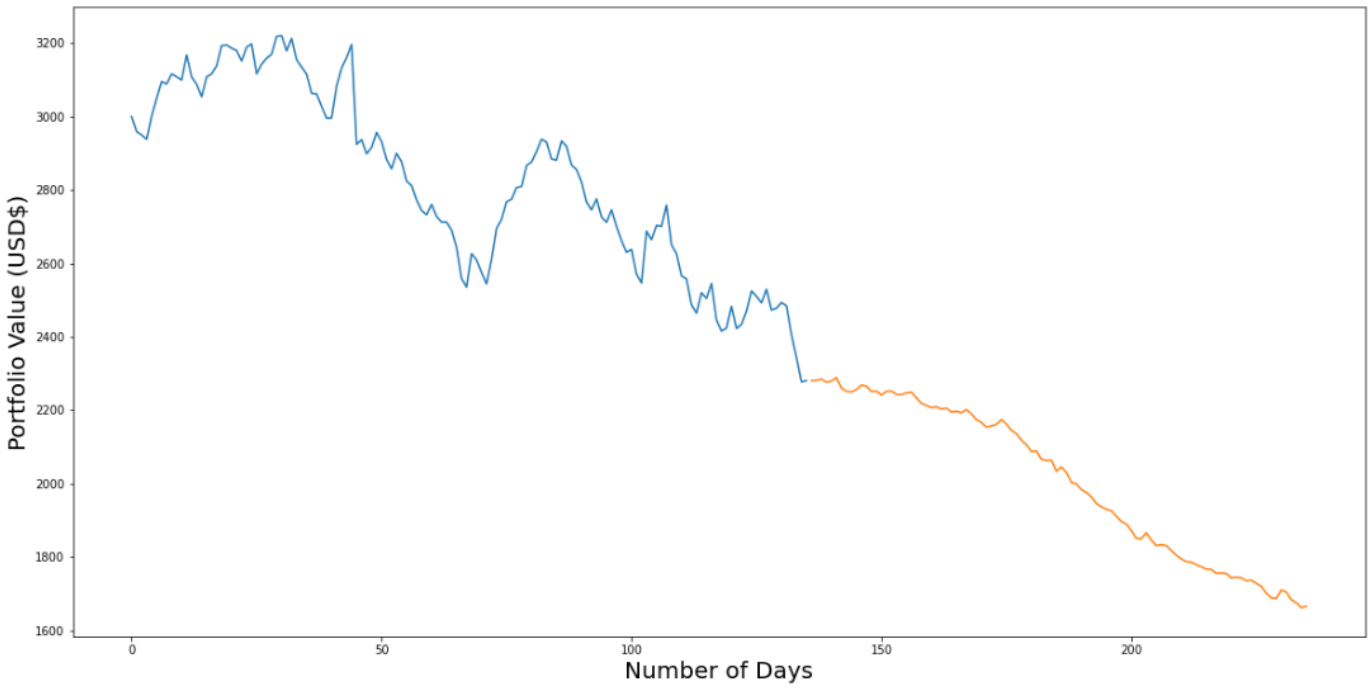
HIGH RISK – HIGH RETURN PORTFOLIO




```
Current Portfolio daily value is  1580.7942227641522
Max avg Portfolio in next 100 days is 1580.7942227641522
Min avg Portfolio in next 100 days is 989.264291954446
```

Current portfolio value (with initial investment $3000) = 1500.79
Max avg Portfolio in next 100 days is $1500.794
Min avg Portfolio in next 100 days is $989.26

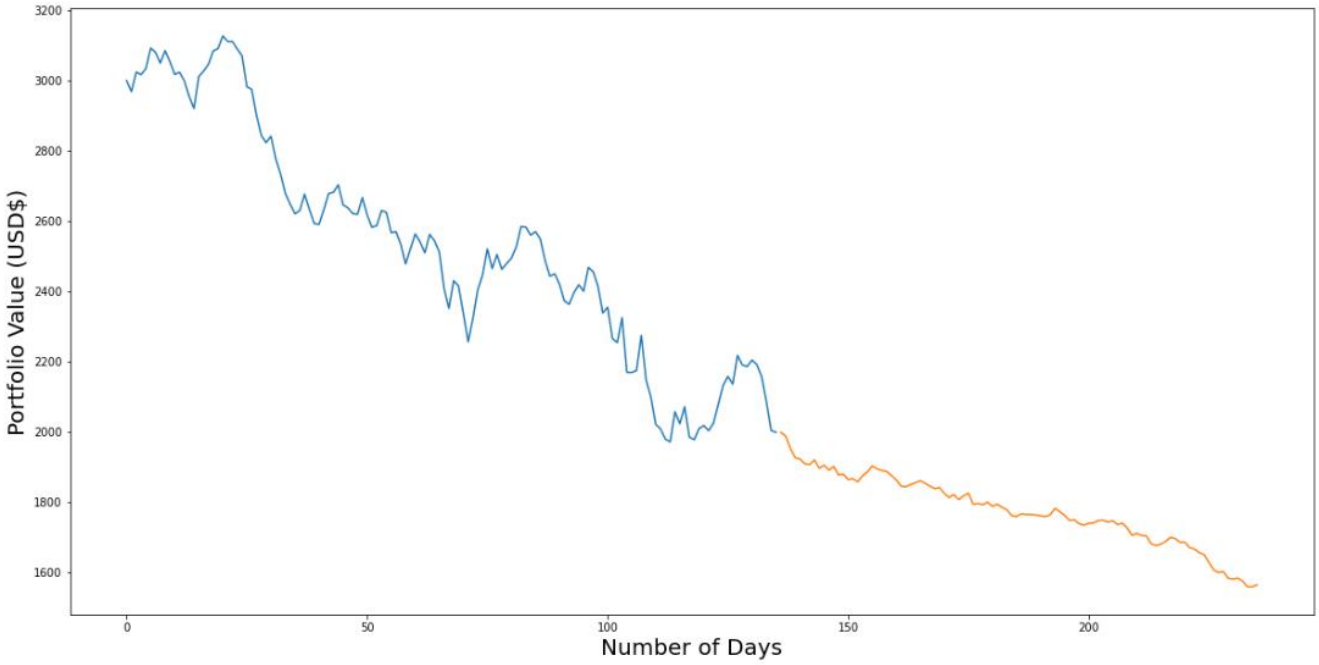
MEDIUM RISK – MEDIUM RETURN PORTFOLIO




```
Current Portfolio daily value is  2280.8136512970873
Max avg Portfolio in next 100 days is 2288.78118037578
Min avg Portfolio in next 100 days is 1661.7353417991508
```

Current portfolio value (with initial investment $3000) = $2200.01
Max avg Portfolio in next 100 days is $2200.01
Min avg Portfolio in next 100 days is $1661.735

LOW RISK – LOW RETURN PORTFOLIO




```
Current Portfolio daily value is  1997.8877975749551
Max avg Portfolio in next 100 days is 1997.8877975749551
Min avg Portfolio in next 100 days is 1557.3003284570207
```

Current portfolio value (with initial investment $3000) = $1997.88
Max avg Portfolio in next 100 days is $1997.88
Min avg Portfolio in next 100 days is $1557.30

In this downtrend market, medium and low risk portfolio perform much better than high risk portfolio, due to their lower variances and lower beta of each component.

Conclusions

As shown above, Monte Carlo is a powerful tool to project random simulations, but the results are still pretty much suffering from the biasness of the existing data. Hence besides the forecast, we should also consider other methods of investment (such fundamental analysis and studies of other macro events of the respective industries) and trading to arrive at best possible investment strategies and stocks pick.

In either case, it also depends on the risk's appetite of the investors. If investors have high risk tolerance and are willing to bet on the uptrend of the market, then he or she can invest in the high-risk portfolio and take advantage of the high volatility and high risk adjusted returns of each component of the markets.

From author's perspective and risk tolerance, medium risk portfolio is the best recommendation for an investor with long-term horizon and relatively low risk's appetite.

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