



**Northumbria  
University**  
NEWCASTLE



# INVESTMENT AND RISK MANAGEMENT

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# 1. Portfolio Overview

## 1.1. Passive Portfolio

This section of the report will review the results from XYZ's passive portfolio. This portfolio was created five years ago for client XYZ, who approached me with £1,000,000 to invest. After a detailed discussion and an analysis of the client's investment objectives and risk appetite, it was agreed that the funds would be invested passively for the first five-year period.

### 1.1.1. Investment Philosophy

According to William Sharpe's investment theory, active investing is essentially a zero sum game before costs and hence a negative-sum game after accounting for the costs associated with buying and selling. This implies that following a passive investment strategy of simply buying and holding assets would lead to a better performance than many actively managed investments funds as it keeps costs to a minimum (Sharpe, 1991; Blitz, 2014).

For this passive fund, a top down approach was applied. The top down approach begins with a broad overview of the global market, reviewing variables such as inflation and GDP, this economic forecast is available in Appendix 2. . Following this, the analysis narrows to consider different industries and sectors. This step aims to minimise risk and maximize returns by accounting for the fact different industries will inevitably react differently to the same event. Neely and Cooley (2004) found that almost half of the funds they surveyed had selected their stocks without consideration of the industries included. The final stage of the top down approach is a fundamental analysis of the security's intrinsic value relative to the security's market value (Dolan & Stevens, 2010).

### 1.1.2. Investor Profile

Client XYZ is an inexperienced investor that has inherited a large sum of money from a deceased relative. They wish to invest this money in order to fund their children's university studies as well as paying of their own mortgage. As the client's children are still young, there is no immediate need for a large influx of cash and so the money will be invested passively for an agreed period of five years with the possibility of changing to active investment in the future. While the client would like to see a decent return from this investment, they are somewhat risk adverse as these funds are necessary for their children's education, hence the risk tolerance level has been classed as moderate. A risk analysis is available in Appendix 1.

### 1.1.3. Passive Portfolio Results

This portfolio began with an investment of £1,000,000 and after a successful period of 5 years passive investment. The portfolio gained £1,414,850 bringing the total to £2,414,850. This money was then reinvested into the active portfolio.

## **1.2 Active Investment Portfolio**

After five years of passive investment, client XYZ has agreed to change the investment strategy and invest actively for a trial period of ten weeks. The client is pleased with the results so far and following a reassessment of the client's objectives and risk appetite, it is evident that their investment objectives have not changed.

### **1.2.1. Investment Philosophy**

Choosing to manage the portfolio actively is essentially challenging the previously mentioned Sharpe theory that actively managed funds result in no gain after the deduction of fees. By choosing to actively manage this portfolio we are deciding to view the market as inefficient, aiming to facilitate a return higher than the market return for securities with equal risk (Cox, 2017).

Tactical asset allocation (TAA) was applied to exploit any inefficiencies in the market. TAA refers to the active adjustment of a portfolio's asset allocation based on short term market forecasts and fluctuations (Stockton & Shtekhman, 2010). An overview of portfolio management is available in the next section.

## **1.3. Asset Allocation**

Diversification is often considered the main method of reducing volatility while maintaining its expected returns, while total protection from risk is impossible due to systematic risk (Neale and Pike, 2009; Rubinstein, 2002), studies suggest diversification can reduce portfolio risk by up to 30% (French & Poterba, 1991, Roberts & Bernstein, 2000). For this portfolio, the principals of Markowitz's modern portfolio theory (MPT) were utilised. This theory states that assets with less correlation will present less risk as they will respond differently to volatility in the markets. (Markowitz, 1952; 1991). In addition to MPT, the portfolio was diversified across different industries and countries. While both methods show significant results (Aked, Brightman and Cavaglia, 2000), studies suggest that industry diversification is more relevant than country diversification and so more focus was on including a range of industries (Baca, Garbe and Weiss, 2000; Morrison & Tuominen, 2018).

### **1.3.1 Portfolio size**

Regarding the amount of equities within a portfolio, literature has not agreed on a specific number that minimises risk, with renowned theories ranging from 10 equities (Evans & Archer, 1968) to 30 equities (Statman, 1987). For the passive portfolio, a mid point of 20 equities was used, although this figure varied in the active portfolio with the buying and selling of stocks.

### **1.3.2 Diversification**

Diversification strategies were applied to both the equity and bond portfolios. The portfolios were diversified by sector as well as country. Full details of diversification are available in appendix 3.

## 2. Equity Portfolio Management

In addition to diversifying the portfolio, there was a range of selection criteria implemented. The beta value of each stock was calculated and was an important factor in which stocks to invest in. The beta was used to calculate CAPM, which in itself was utilised as well as the successive theories such as Jensen (1968), Sharpe (1966) and Treynor (1965) amongst others, located in Appendix 7.

### 2.1 Efficient Market Hypothesis

Malkiel & Fama's 1970 theory of market efficiency is highly debated amongst academics and investors, with the inefficiency of the stock markets being a fundamental assumption of active fund managers (Beechey, Gruen & Vickery, 2000).

The exploitation of market inefficiency is what allows for investors to beat the benchmark, with this notion being essentially prevalent during times of crisis and financial turbulence (Basu, 1977; Fox & Sklar, 2009). Taking into consideration the current state of the economy and volatility of the markets, this portfolio aims to exploit market inconsistencies by incorporating current news to predict possible stock movements (Fawcett & Provost, 1999).

### 2.2 Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model of Sharpe (1966) and Lintner (1965) is used to quantify the relationship between the systematic risk and expected return of an equity. There are many criticisms of the model stemming from theoretical failings, as a result of assumptions made, such as the assumptions that markets are efficient, investors are risk adverse and transactions costs are not present. Despite these assumptions, the CAPM model is widely accepted by many academics (Blume & Friend, 1973; Fama & French, 2004). The CAPM expected return of the portfolio equities ranged from a low of 1.1% to a high of 6.42%, with the portfolio expected return at 4.30%. These figures are charted in figure 2. The expected return was calculated as shown below in Figure 1

*Figure 1*

$$ER_i = R_f + \beta_i(ER_m - R_f)$$

Where:

$ER_i$  = Expected Return of Investment

$R_f$  = Risk-Free Rate

$\beta_i$  = Investment Beta

$(ER_m - R_f)$  = Market Risk Premium

*Derived from (Reilly & Brown, 2015)*

#### **2.2.1 Beta Values**

While Beta is used in the calculation of CAPM, it is also a useful tool itself. Beta is a simple measure of systematic risk assigned to equities and signifies the volatility of a stock when compared to the market (Mullins, 1982). For this portfolio, due to the client's moderate risk tolerance, and increased market volatility, the investor chose to only purchase equities with a beta below one with the exception of Netflix, as it was significantly undervalued at the time so was deemed a safe purchase.



Table 1

Stock	ARYAU US	ATIF US	ATVI US	AZN LN	CEY LN	CFFAU US	CLX US	CTXS US	EA US
Beta	-0.08	0.26	0.92	0.73	0.54	-0.01	0.39	0.75	0.83

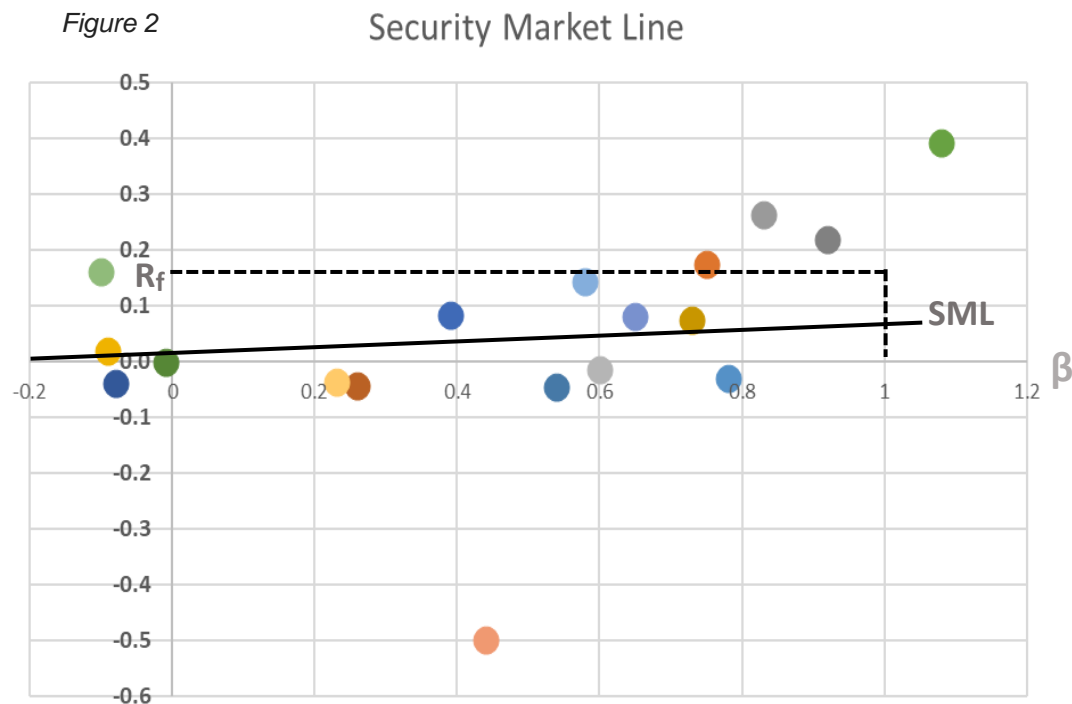
  

Stock	HCCHU US	HSTM US	NFLX US	PG US	PHGE/U US	SBRY LN	SPAQ/U US	WMT US	ZM US
Beta	-0.09	0.78	1.08	0.65	0.44	0.6	0.23	0.58	-0.1

### 2.2.2 Security Market Line

The security market line is a graphical representation of the CAPM results. The Alpha (or market risk premium) figure is calculated by deducting the actual return from expected return to deduce how the equity exceeds expectations (Sinha, 2012).

Shares that performed below their expected return are considered overvalued and vice versa, the SML helps visualise which shares are overvalued by plotting them below the SML line or undervalued, which will be above the SML line (Dybvig & Ross, 1985; Green, 1986). As seen in figure 2, while more of the stocks were undervalued than overvalued. There are some outliers, with BiomX Inc (PHGE/U) very overvalued and Netflix (NFLX) very undervalued.



### 2.2.3 Multi Factor Model

While CAPM can be used to demonstrate the relationship between risk and return, it only considers deviation in returns as a source of systematic risk (Bello, 2008). Fama and French modified this by increasing it into a three factor model, by adding factors relating to size and value (Fama & French, 2004; Durand, 2011). Having ran the multi factor model on this portfolio we see that there is no presence of small stocks effect or value premium effect, and that the p-value is only statistically significant for the market risk factor and with a negative coefficient.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
<b>Intercept</b>	-1.332098709	0.696081681	-1.913710337	0.113843194
<b>Mkt-RF</b>	-0.360949722	0.096557532	-3.738182977	0.013456757
<b>SMB</b>	-0.299285516	0.209742723	-1.426917281	0.212949307
<b>HML</b>	0.029378423	0.304917278	0.096348829	0.926986189

## 2.3 Fundamental and technical analysis

### 2.3.1 Past stock price movement

The use of past stock data rejects the fundamental assumptions of EMH as discussed above, however studying the past movements of a stock or the market itself can help give an indication of volatility or sentiment, (Engle, 1982; Koopman et al, 2005; Khedr & Yaseen, 2017). While the use of historical data is limited (Liow, 1997), this portfolio did observe historical performance when choosing stocks for the portfolio.

### 2.3.2 P/E ratio, Gordon's growth model

The P/E ratio is another method of valuing an equity, it is equal to the share price divided by earnings per share (Shen, 2000; Gottwald, 2012). This ratio helps to determine if the stock is correctly priced, with theory suggesting that low P/E ratios will outperform higher p/e shares (Nicholson, 1960).

Figure 3

$P = \frac{D_1}{r - g}$	<p>Where:</p> <p><math>D_1</math> = Dividend</p> <p><math>r</math> = Rate of Return</p> <p><math>g</math> = Growth rate</p>
-------------------------	---

*Adapted from Gordon (1962)*

Gordons Growth model (figure 3) was also implemented alongside P/E ratio to help deduce if the shares were valued correctly. GGM relates the value of a stock to its expected dividends and expected growth rate in dividends (Armour et al, 2016). While the Gordon growth model can be a good indicator of price, it is considered fundamentally flawed by some, due to its assumptions and so it will be utilised as a secondary method, having consulted the SML line and Intrinsic price first.

## 3. Bond Portfolio Management

### 3.1 Credit ratings

Credit ratings were an important factor in bond selection. The Standard and Poor's Global Ratings were used in line with using S&P as a benchmark, however Moody's ratings were also considered in order to have an accurate picture of the bond, these are two out of three of the best credit agencies in the world. These credit rating agencies gather a range of information to make informed judgments about their creditworthiness (White, 2018).

In order to assure that the bonds chosen were unlikely to default, only bonds with a rating of A or above were considered, as shown in appendix 5.

### 3.2 Interest rates

Interest rate volatility has a direct effect on bond prices; however, they move in opposite directions, e.g. a rise in interest rates causes a fall in bond prices and vice versa (Shiller, 1979). This correlation will have more effect on short term bonds than long term and so short term bonds are considered less risky. This relationship means that interest rates are a significant variable when it comes to bond pricing.

### 3.3. Yields

A bond's yield reflects the return to investors from the coupon and maturity cash flow. The yield curve acts as a graphical representation of the yield expected over different periods of time, by plotting the bond's yield against the time to maturity. While the curve can form many shapes, it is normally upward sloping indicating that bonds with longer maturities attain higher yields (Campbell, 1995).

Figure 4

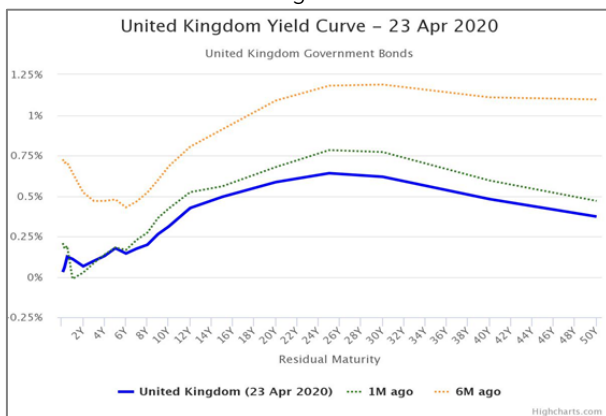
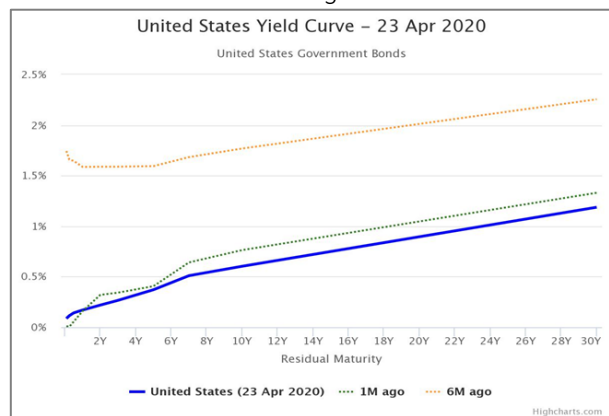


Figure 5



(World Government Bonds, 2020).

### 3.4 Duration, Modified Duration

Duration is a measurement of the sensitivity of bond price to fluctuations in interest rates, it is considered a better way to summarize the timing of bond flows than maturity (Reilly & Sidhu, 1980). Bonds with higher duration will be susceptible to greater impact of sensitivity towards interest rate volatility (Hatchondo & Martinez, 2009)

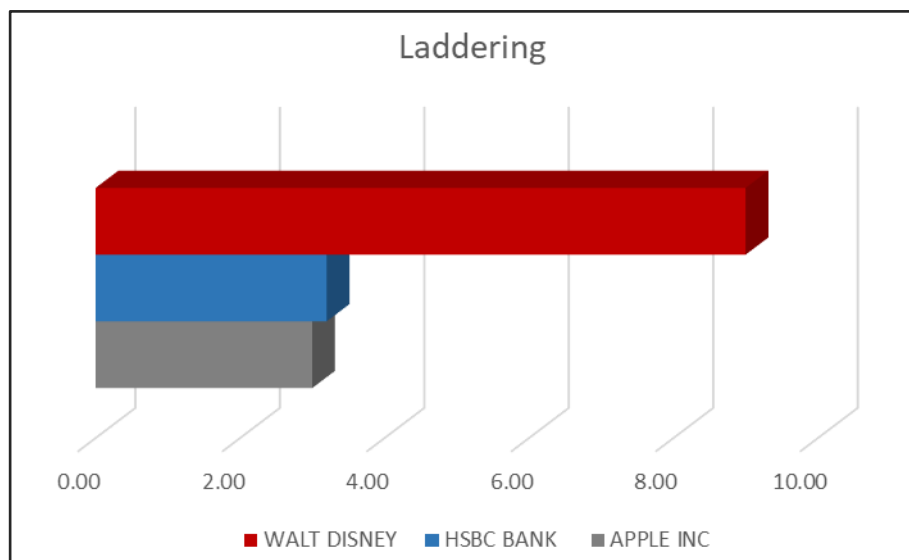
Table 2

Name	Duration	Modified Duration
APPLE INC	5.58	5.55
WALT DISNEY	15.52	15.20
HSBC BANK	2.80	2.74

### 3.5 Bond laddering

Bond laddering is essentially another method of diversification, this strategy involves buying bonds with different maturity dates to minimise the impact of changing interest rates, as the investor can respond more timely to any changes. While there was attempts to imply laddering techniques, there was other criteria deemed more important and so two bonds had the same maturity.

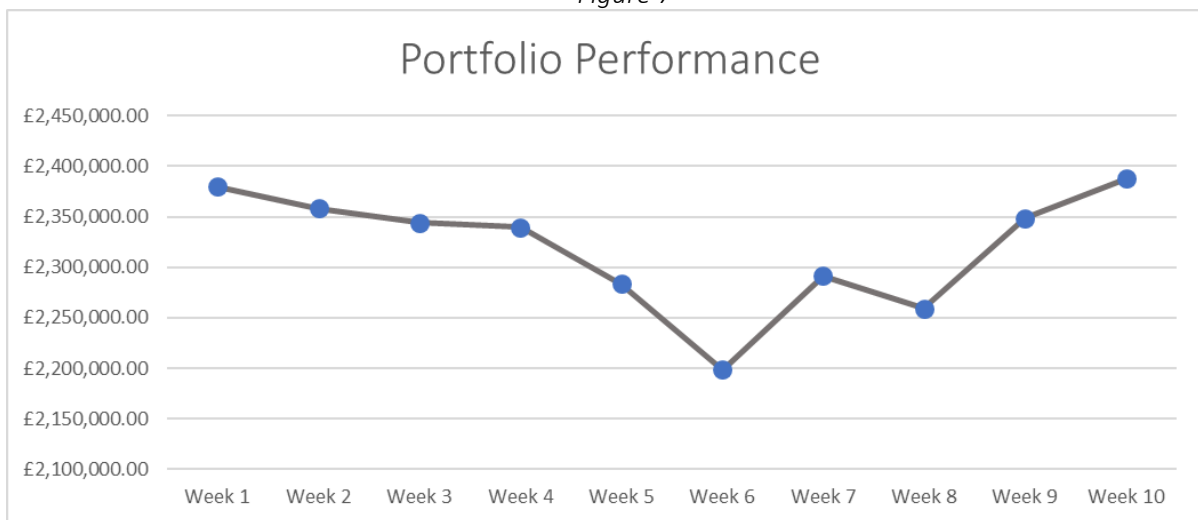
Figure 6



## 4. Portfolio Performance Evaluation

Many methods were applied in order to evaluate the portfolios performance, including the application of a wide range of theories and ratios as shown in Table 3. A full analysis of these figures is available in appendix 7. The passive portfolio increased by 141.49% to turn the initial £1,000,000 investment into £2,414,850, this was the starting amount for the active portfolio. Overall, the portfolio did finish with a profit of £15,443 bringing the total to £2,430,293. While this was only an increase of 0.64%, the active portfolio was operating in particularly volatile times that seen coronavirus cause some of the biggest stock market losses since the recession. Hence, while profits were small, they are better than losses and so this portfolio could be classed as successful.

Figure 7



Unfortunately, the portfolio did not beat the benchmark in this case however it did finish as a profitable portfolio. The ratios in table 3 give a better indication as to portfolio performance and are discussed in detail in appendix 7

Table 3

<b>Sharpe Ratio</b>	0.1195
<b>Treynor Ratio</b>	0.0561
<b>Jensen's Alpha</b>	-0.1100
<b>Tracking Error</b>	0.1910
<b>Information Ratio</b>	-1.5077
<b>Coefficient of Variation Ratio</b>	4.9197
<b>M2 ratio</b>	0.0277
<b>Calmar</b>	0.5440

## 5. VAR

Risk management is an essential part of portfolio management, to help the investor cope with any sudden changes in the market (Orhan & Köksal, 2012; Teller & Kock, 2013). This portfolio has implemented many methods of reducing risk, from diversification to strategic equity selection. A popular method of measuring this risk is Value-at-Risk or VAR, which is used to summarise the portfolios exposure to risk in a single figure (Jorion, 1996). The VAR figure is essentially an estimate of the largest loss that the portfolio would suffer under normal market changes (Hopper, 1996). This helps the investor to balance their portfolio to secure the greatest expected return with the least level of risk (Beder, 1995).

There are three main methods of VAR, namely historical simulation method, variance-covariance method (sometimes referred to as Delta-normal approach), and the Monte Carlo simulation. The methods all differ slightly and so their results will too, for example, one method may show good results for a portfolio in the short run, but not work well over a longer period of time (Hopper, 1996). For this reason, all three methods were implemented to assure that the portfolios risk was measured accurately.

### 5.1 Methods of VAR

Firstly, there was historical simulation, which uses historical data and replicates the portfolios current reactions (Jorion, 1996). This method is completely nonparametric so is not required to fit a normal distribution which captures nonnormality in the data however ignores volatility (Christoffersen & Gonçalves, 2004). The issues with this is that volatility will vary over time and by ignoring this, the results could be slightly skewed (Hopper, 1996; Linsmeier & Pearson, 2000).

The second method was variance-covariance, which assumes that market factors follow a normal distribution. This distribution is utilised to determine the portfolio loss that will not be exceeded x% of the time (Linsmeier & Pearson, 2000). This method builds a variance-covariance matrix of portfolio changes assuming normally distributed changes in the market to measures the maximum loss as a certain level of confidence (Benninga & Wiener, 1998).

Third was the Monte Carlo simulation, which creates a large number of possible scenarios and the associated losses of that scenario. This method implements random number generation in order to generate thousands of hypothetical changes in the market leading to thousands of hypothetical portfolio losses to determines the portfolio VAR (Benninga & Wiener, 1998; Linsmeier & Pearson, 2000).

## 5.2. VAR Results

The VAR was calculated for 90%, 95% and 99% confidence, however this portfolio will focus on the 95% confidence figures. The results are given in GBP indicating the maximum amount of money the portfolio would lose 95% of the time. The three methods gave varied results, ranging from a loss of 43K to 64K, which signified a loss of 5.5% to 8% respectively. Further details about the calculation of VAR are in appendix 9.

Table 4

HS Given VAR	90%	95%	99%
	-£60,818.55	-£64,392.67	-£67,251.97
VCV Given VAR	90%	95%	99%
	-£42,062.74	-£54,363.92	-£77,438.89
MCS Given VAR	90%	95%	99%
	-£30,294.97	-£43,912.19	-£54,805.96

There are some flaws with VAR in that each method is essentially only an estimate, and hence liable to a level of estimation risk itself. As VAR does not incorporate variables such as political risk, liquidity risk or regulatory risk, if any of these atypical market fluxuations were to occur they would be outside the scope of VAR estimates. This is particularly prevalent currently as the market is abnormally volatile due to the impact of coronavirus. While there are some limitations of VAR, it is still considered the most popular method of measuring portfolio risk, and by implementing all three methods, the investor will have a better picture of possible losses (Beder, 1995; Jorion, 1996).

## 6. Option Strategy

Having measured the risk of the portfolio, it was important to seek a method of hedging the risk of volatility and changes in the market. Hedging is used to reduce the risk of a particular investment by taking on another investment (Naik, 1993).

Options are a form of hedging, an option grants the holder of the option the right, but not necessarily the obligation to buy or sell a share at a set price. There are two types of option, the call option gives the holder the right to buy the share at a certain price and the put options gives the holder the right to sell the share at a certain price, both by an assigned date (Hull, 2014).

A straddle is an options strategy that involves simultaneously purchasing both a call and put option with the same price and the same expiration date.

If the investor believed that Activision shares might rise or fall, but were unsure of which, they could hedge the risk by creating a straddle. This involves the purchase of both a call and put option at the current price of \$65 with an expiration date in the near future. The price of the \$65 call and \$65 put would combine to be the total cost of the straddle, or premium. The premium in this case was \$5 meaning that the stock needs to rise or fall around 8% ( $5/65$ ) in order to make a profit.

Figure 8

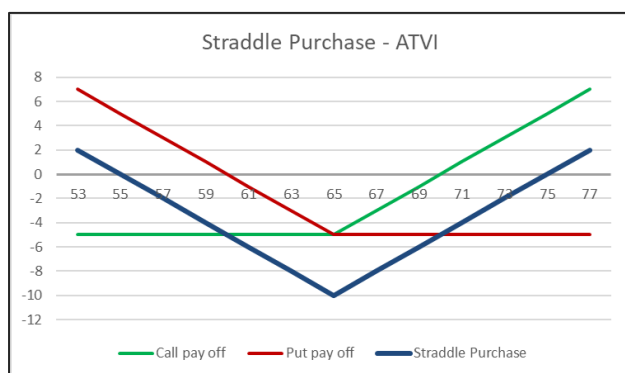
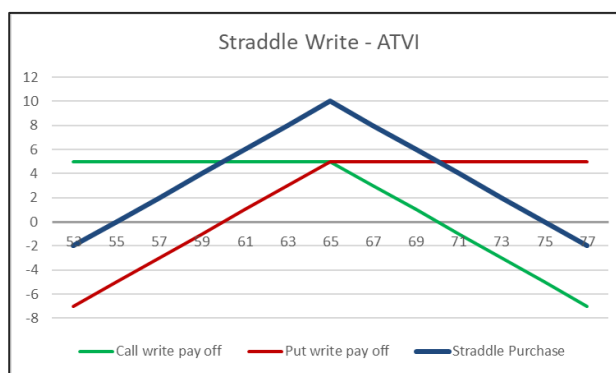


Figure 9



Within the straddle there was two methods implicated, a straddle write and a straddle purchase. The straddle purchase involves buying both a call and a put with the same terms, while the straddle write would involve selling a call when the seller does not yet own the stock. The two methods have contrasting results in that the profit of a straddle write would be opposite to that of a straddle purchase, with the straddle purchase yielding a V shaped profit graph and straddle write an inverted V, as shown in figures 8 and 9. The straddle for ATVI has two break-even points at £55 and £75.



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## 7. Appendix One – Risk Assessment

As discussed in section one, Client XYZ is an inexperienced investor that has invested their £1,000,000 inheritance into a portfolio of stocks and bonds. After a successful five year period of passive investment, the portfolio was changed to active investing. The client does not need high levels of liquidity as they have other cash reserves available, and the time span for the portfolio is longer term as the money is to be used for his children's education as well as the mortgage on a property. Having conducted a number of tests with numerous investment professionals, the clients risk tolerance was classed as moderate. This risk tolerance was incorporated into every aspect of the portfolio selection in order to assure that the risk level of the portfolio was in line with the client's desires.

*Table 5*

 (StandardLife, 2020)	<p style="text-align: center;"><b>Med - High Risk</b></p> <p>Oxfords risk tolerance assessment scored the client <b>37/50</b>, placing them in the Medium to High Risk category.</p>
 (Vanguard, 2018)	<p style="text-align: center;"><b>Moderate Risk</b></p> <p>Vanguards risk tolerance assessment recommended a 50/50 split of equity and bonds</p>
 (CALCXML, 2020)	<p style="text-align: center;"><b>Moderate Risk</b></p> <p>The CalcXML risk tolerance assessment scored the client <b>54/80</b> suggesting the client is at moderate risk level.</p>
 (BrightStart, 2020)	<p style="text-align: center;"><b>Moderate Risk</b></p> <p>The Bright Start risk tolerance assessment categorises this client as moderate risk</p>
 (University of Missouri, 2020)	<p style="text-align: center;"><b>Moderate Risk</b></p> <p>University of Missouri's risk tolerance assessment scored the client <b>28/847</b> suggesting the client is at moderate risk level.</p>

## 8. Appendix Two – Market Forecast

The active investment period may only be 12 weeks, however the economy is particularly volatile due to the coronavirus and Brexit, and so it was crucial to conduct a market forecast to assess the variables that may affect the portfolio.

Table 6

	Current Rate	Q1 Performance	Forecast
GDP	- 4.8%	↓	↓
Inflation	0.3%	↓	→
Unemployment	14.7%	↑	→
Interest Rates	0	↓	↓
USD/GDP	1\$ = £0.82	↘	↗
GBP/USD	£1 = 1.23\$	↓	↓

### GDP

While the 4<sup>th</sup> quarter of 2019 displayed a GDP rise of 2.1%, this was followed by a stark increase in the 1<sup>st</sup> quarter of 2020, where the US seen its first decline since 2014, and greatest quarterly decline since the 2008 recession, with a GDP of -4.8%. This figure is only expected to get worse with economists predicting this could fall as low as it did during the great depression.

(BEA, 2020; Casselman, 2020)

### INFLATION

Inflation has fallen from 2.3% when active trading began in February to 0.3% as of April, similarly to GDP this is the worst drop since the 2008 crisis and demonstrates how distressed the market is.

(Smith, 2020; TradingEconomics, 2020)

### UNEMPLOYMENT

April also seen landmark statistics for unemployment, with a rise of 10.3 percentage points to 14.7%. This is both the highest rate and largest monthly increase known, since the data began in 1948. While the rate of layoffs appears to be slowing, there is no sign of a significant rise in employment coming any time soon.

(Bureau of Labour Statistics, 2020; Rushe, 2020).

!

## **INTEREST RATES**

In an unprecedented move, the Federal Reserve cut the interest rate to zero in March, in an attempt to minimise the effects of economic downturn. While this was impactful itself, there is speculation that we may even see negative interest rates soon.

(Financial Times, 2020; Smith, 2020)

## **USD & GBP**

The effects of changes in these rates are particularly prevalent in this portfolio as these are the two active currencies in both the bond and equity portfolio. With much uncertainty surrounding Brexit and coronavirus, the British Pound has been particularly volatile falling nearly 3% against the dollar in May, the worst performance amongst major currencies. Year-to-date, the pound has fallen nearly 8% against the dollar, which has conversely, been rising steadily since hitting a low in March, with a recent rise of 7% against other main currencies.

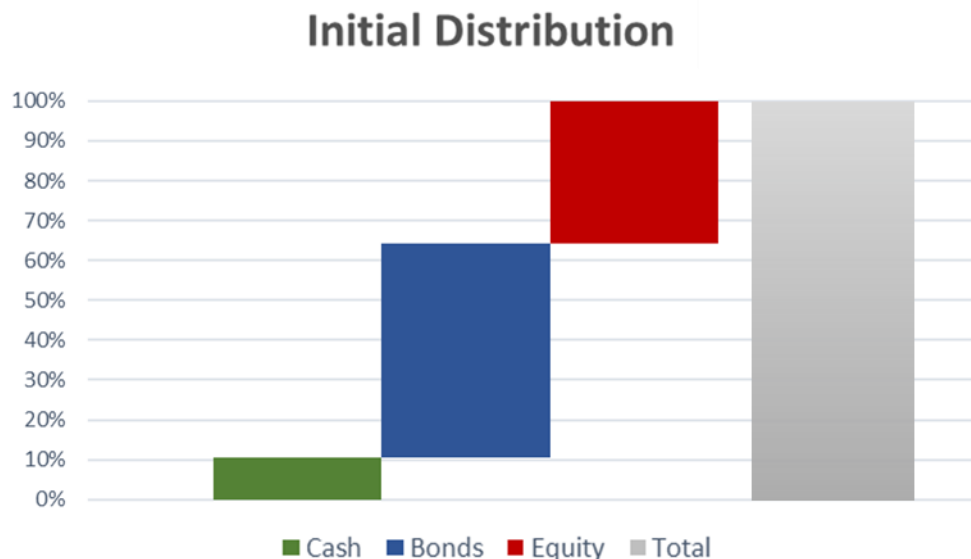
(Kollmeyer, 2020; LaMonica, 2020)

## 9. Appendix Three – Portfolio Allocation

### 9.1. Asset Allocation

Initial investment for the active portfolio was £2,414,850, which was been split between equities and bonds at an approximate 60/40 rate, based on the risk analysis. In practice, this became a 55/35 split of equities and bonds to leave 10% free cash. The cash surplus was left aside for liquidity reasons as well as to have available cash if an attractive stock opportunity arose.

Figure 10



### 9.2. Equity diversification

In relation to the aforementioned MPT (Markowitz, 1952: 1991), the majority of stocks chosen for the portfolio had low correlation with almost a quarter having negative correlation, to help minimise effects of volatility, see appendix 6 for the Correlation matrix.

Additionally, industry diversification was applied with 4 sectors and 8 sub-industries in the passive portfolio, rising to 6 sectors and 11 sub-industries after readjustments in the active portfolio, see figures 11 and 12 below.

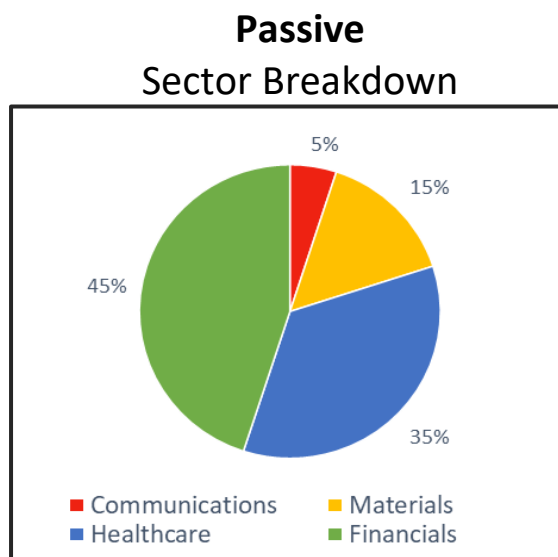


Figure 11

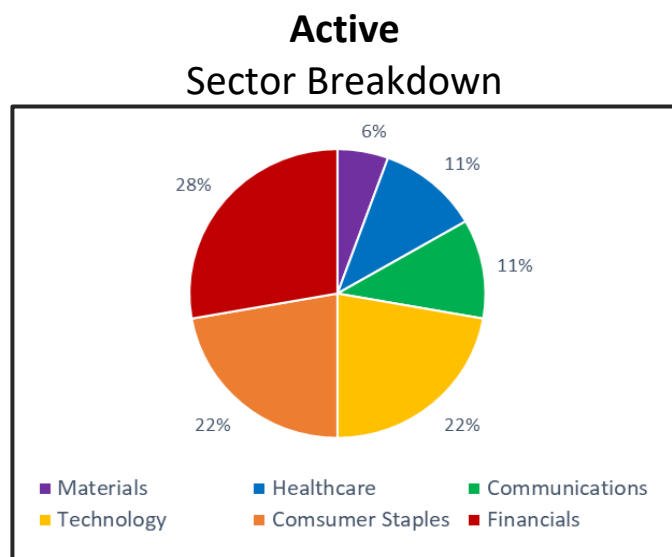


Figure 12

Furthermore, both passive and active portfolios were diversified internationally (figures 13 & 14) as they contained equities from both USA and UK. As the weeks progressed in active management, the portfolio became mainly US stocks as these were performing better throughout the economic downfall.

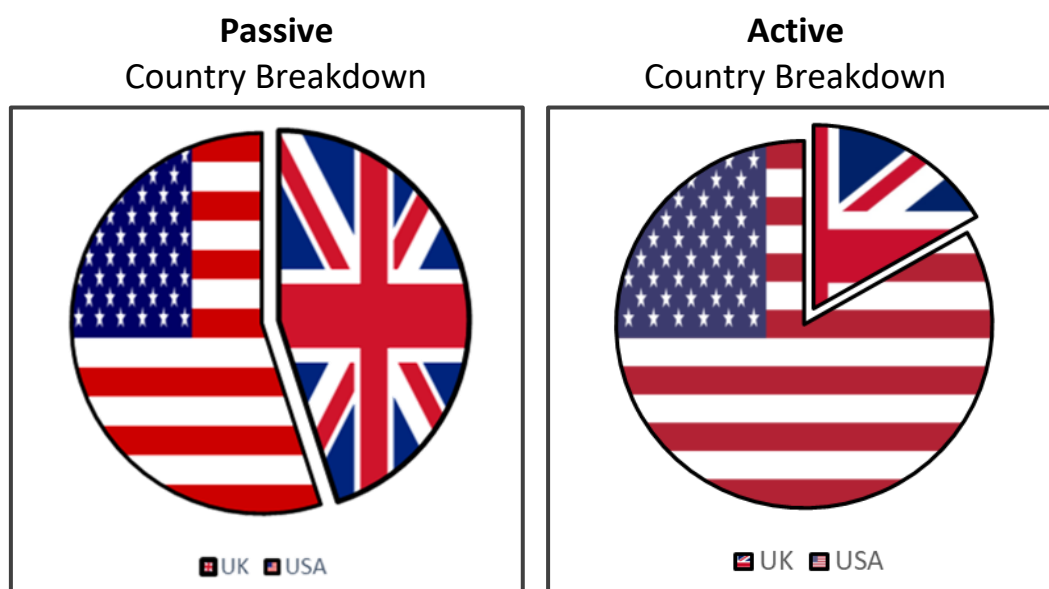


Figure 13

Figure 14

### 9.3 Bond diversification

Bond diversification differed from equity as bonds have been proven to have less linkage to bad news and market volatility (Kaplanis & Schaefer, 1991; Engle and Sheppard, 2006). There are substantial arguments to suggest that factors such as credit rating can outweigh any benefits of diversification in respect to bonds, therefore slightly more focus was put on credit rating than bond diversification and all bonds selected were of a very high rating as displayed in appendix 5

While focus was on the ratings, there was still attempts to diversify. The correlation between bonds was examined and the matrix can be seen in appendix 7. Two thirds of the bonds showed negative correlation with the remaining third showing slightly high correlation.

As well as correlation, sector and country diversification were noted, with the 3 bonds coming from 3 different sectors in an attempt to further reduce risk. Regarding international diversification, the portfolio was again split between UK and USA bonds. The choice to limit country diversification to only two countries for both bonds and equity was due to currency risk. Investing in international markets exposes the client to currency risk through the volatility of exchange rates (Kaplanis & Schaefer, 1991; Haslem, 2009).

## 10. Appendix Four – Benchmark Selection

### 10.1 Benchmark Selection

As my portfolio consists of 55% US equity and 66% US bonds, the S&P 500 Index was chosen as a benchmark. When selecting this benchmark there was a number of factors to consider, the CFA cite the following characteristics as necessary for a suitable benchmark. (Table 7)

Table 7

<b>Benchmark Characteristics</b>	<b>Description</b>	<b>S&amp;P 500</b>
<b><i>Unambiguous</i></b>	The identities and weights of securities are clearly defined	✓
<b><i>Investable</i></b>	It is possible to forgo active management and simply hold the benchmark.	✓
<b><i>Measurable</i></b>	Benchmark return is readily calculable on a reasonably frequent basis	✓
<b><i>Appropriate</i></b>	The benchmark is consistent with my investment style	✓
<b><i>Reflective</i></b>	The manager has current investment knowledge of the securities within the benchmark	✓

### 10.2 Expected Return

The probabilities and the returns were calculated using historical data from the Standard and Poors 500 over the past two years

Probability of Bear market = 24%

Return of Bear market = -3.68%

Probability of a Bull market = 76%

Return of Bull market = 3.23%

$$\begin{aligned} E_{re} &= (P_{\text{Bear}} \times R_{\text{Bear}}) + (P_{\text{Bull}} \times R_{\text{Bull}}) \\ &= (24\% \times -3.68\%) + (76\% \times 3.23\%) \end{aligned}$$

Expected Return = 1.57%



### 10.3 Standard Deviation

$$\begin{aligned}SD &= \sqrt{(P_{\text{Bear}} \times (R_{\text{Bear}} - E_{\text{re}})^2) + (P_{\text{Bull}} \times (R_{\text{Bull}} - E_{\text{re}})^2)} \\&= \sqrt{(24\% \times (24\% - 1.57\%)^2) + (76\% \times (76\% - 1.57\%)^2)} \\&= 4.02\%\end{aligned}$$

As the standard deviation of the benchmark is not high, it is appropriate to Hanna's risk tolerance, which is classified as risk adverse.

### 10.4 Utility Score:

Since the risk tolerance score of moderate is 3. The utility score is found

$$\begin{aligned}US &= ER - \frac{1}{2}A\sigma^2 \\US &= 1.57\% - \frac{1}{2}(3)(4.017\%)^2 \\US &= 1.33\%\end{aligned}$$

Although a higher utility score may insinuate the possibility for higher return, the clients moderate risk tolerance means that the average utility score is expected. The lower the risk tolerance, the lower the utility score is likely to be.

## 11. Appendix Five – Bonds

### 11.1 Bond Selection

As discussed in appendix 3, there was both sector and country diversification for bonds, with three different sectors and two different countries included in the bond portfolio. However, the main focus in this portfolio's bond selection was credit rating, in order to assure the bonds did not default. Other factors considered include maturity and correlation.

*Table 8*

Tag	Name	Issue	Maturity	Coupon	Issue Price	Currency	Country
AAPL 2.4	APPLE INC	03/05/2013	03/05/2023	2.4	£79.72	USD	USA
DIS 2	WALT DISNEY	06/09/2019	01/09/2029	2	£77.00	USD	USA
HSBC 6.5	HSBC BANK	07/07/1998	07/07/2023	6.5	£109.23	GDP	UK

### 11.2 Maturity

The selected bonds have maturities within a 10 year range to soften the effects of bond price volatility. The maturity of the bonds is an important factor in how the bond price reacts to fluctuations in interest rates, which was discussed alongside duration in section 3.

### 11.3 Country

The Bonds chosen were a selection of UK and USA bonds. Country diversification can reduce risk in the case of one's home country becoming unstable. Political instability or market volatility can cause significant increase in risk for an investor and so both countries included in the portfolio are developed nations to minimise these risks, however the portfolio is still prone to currency risk. Currency risk is present in any international investing, as the investor can stand to gain/lose as either nations currency rate changes. The level of currency risk increases with the amount of currencies introduced to the portfolio, and so this portfolio contains investments in only the two biggest and arguably safest markets.

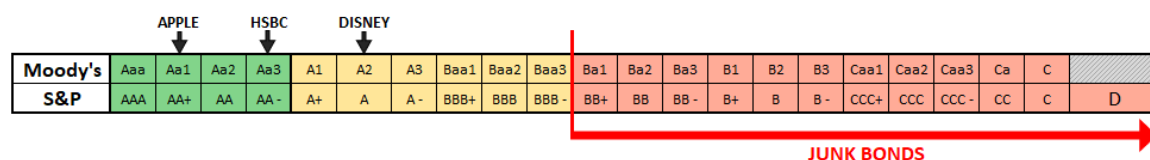
## 11.4 Credit Rating

Table 9

Name	S&P	Moody's
APPLE INC	AA+	Aa1
WALT DISNEY	A	a2
HSBC BANK	AA -	Aa3

Credit ratings were an important factor in this portfolio for risk management purposes. Bonds with a lower credit rating, such as junk bonds, are more likely to default. Apple and HSBC both rank in the highest category according to both Standard and Poor's Global Ratings and Moody's Investments. As two of the most reliable rating agencies in the world, these ratings meant that the investor could classify them as low risk. The Disney bonds were still classified as A, however they fell into the next category of medium risk. As the clients risk profile was moderate, two thirds low risk and one third medium risk was deemed appropriate.

Figure 15



## 11.5 Correlation

Table 10

	AAPL 2.4	DIS 2	HSBC 6.5
AAPL 2.4	1	-0.486	-0.744
DIS 2	-0.486	1	0.855
HSBC 6.5	-0.744	0.855	1

Due to the small number of bonds held in the portfolio, the correlation was less significant than in the equity portfolio. As seen in table 10, 2 out of 3 bonds showed negative correlation, meaning that these bond prices would move in opposite directions, hedging risk. While HSBC and Disney showed slightly high correlation of 0.855, these assets operate in different countries which should reduce the effect of this correlation slightly.

## 12. Appendix Six – Equities

### 12.1 Equity Selection

The screening criteria was that the stocks should have a health grade above or equal to A as well as a beta lower than 1. I then selected the top 20 stocks in this selection when ranked by P/E ratio. In addition, I included three bonds, namely Apple, Disney and HSBC.

Table 11

	17/02/20	24/02/20	02/03/20	09/03/20	16/03/20	23/03/20	30/03/20	06/04/20	13/04/20	20/04/20	Buy	Sell	Return
ABC LN	Bought	Hold	Sold								12.96	12.60	-2.78%
ANIP US	Bought	Hold	Sold								48.84	36.34	-25.59%
ARYAU US	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	9.14	8.78	-3.91%
ATIF US	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	1.42	1.35	-4.40%
AZN LN	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	75.81	81.50	7.51%
BRK LN	Bought	Hold	Hold	Sold							21.60	17.25	-20.14%
CEY LN	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	1.48	1.41	-4.57%
CFFAU US	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	8.49	8.48	-0.18%
CLIN LN	Bought	Hold	Hold	Sold							8.85	6.67	-24.59%
DPH LN	Bought	Hold	Hold	Hold	Hold	Sold					28.28	24.00	-15.13%
FRES LN	Bought	Hold	Hold	Hold	Hold	Sold					7.06	7.28	3.06%
GORO US	Bought	Sold									4.18	3.63	-13.20%
HCCHU US	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	8.54	8.69	1.82%
HSTM US	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	20.15	19.55	-2.97%
HW/LN	Bought	Hold	Hold	Sold							1.43	1.45	1.75%
LIO LN	Bought	Hold	Hold	Sold							13.25	10.10	-23.77%
PACQU US	Bought	Hold	Hold	Sold							8.44	9.36	10.97%
PHGE/U U	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	8.48	4.25	-49.91%
SPAQU U	Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	8.20	7.89	-3.70%
ZTS US	Bought	Hold	Hold	Sold							112.03	100.88	-9.95%
WMT US			Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	87.81	100.36	14.29%
SBRY LN			Bought	Hold	Hold	Hold	Hold	Hold	Hold	Hold	2.043	2.02	-1.37%
NFLX US				Bought	Hold	Hold	Hold	Hold	Hold	Hold	245.16	341.30	39.21%
ATVI US					Bought	Hold	Hold	Hold	Hold	Hold	42.1	51.34	21.95%
EA US					Bought	Hold	Hold	Hold	Hold	Hold	70.04	88.51	26.37%
PG US					Bought	Hold	Hold	Hold	Hold	Hold	86.19	93.09	8.00%
ZM US					Bought	Hold	Hold	Hold	Hold	Hold	96.25	111.69	16.04%
CTXS US					Bought	Hold	Hold	Hold	Hold	Hold	97.45	114.51	17.51%
CLX US					Bought	Hold	Hold	Hold	Hold	Hold	136.96	148.42	8.37%

Throughout the investment period, numerous methods were utilised to assess whether an equity should be bought or sold. This portfolio used CAPM, P/E Ratio and GGM, amongst others, to assess the equity. One asset that was purchased on week 5 was Activision (ATVI US), this asset was successful with one of the highest returns in the portfolio, as can be seen in table 11 above. The decision to purchase ATVI involved numerous calculations as shown below.

### 12.2 P/E Ratio

**Price Earning Ratio = Intrinsic Value / Earnings per Share**

Price Earnings Ratio = 34.23

Earnings per Share = 1.95

Intrinsic Value = Price earnings ratio x Earnings per share = 66.75

P/E ratio calculations give the price as £66.75

## 12.3 Gordons Growth Model

Gordons Growth Model for ATVI was calculated using the aforementioned formula available in figure ""

Risk Free Rate = 1.55%

Market Expected Return = 6.06%

Growth = 4.69%

Dividend = 0.41

GGM = Dividend divided by rate of return minus growth rate = 65.079

Gordons Growth model gave the price as £65.08

## 12.4 CAPM

The CAPM for ATVI was calculated using the formula in section 2, figure "".

Risk-Free Rate = 1.55%

Beta = 0.61

MKT Expected Return = 6.06%

CAPM = Risk free rate + Beta(Expected return – Risk free rate) = 4.30%

## 12.5 Correlation

Figure 16

	ARYAU US	ATIF US	ATVI US	AZN LN	CEY LN	CFFAU US	CLX US	CTXS US	EA US	HCCHU US	HSTM US	NFLX US	PG US	PHGE/U US	SBRY LN	SPAQ/U US	WMT US	ZM US
ARYAU US	1	0.201	0.255	0.194	0.518	-0.156	-0.371	-0.491	0.332	-0.596	0.543	0.139	0.437	0.396	-0.087	0.496	0.023	-0.699
ATIF US	0.201	1	0.231	0.174	0.031	0.394	-0.077	-0.303	0.262	0.103	0.226	0.324	0.247	0.265	-0.309	0.292	0.063	-0.056
ATVI US	0.255	0.231	1	0.792	0.631	0.258	0.402	0.477	0.963	-0.307	0.876	0.884	0.881	-0.179	0.012	0.712	0.788	0.080
AZN LN	0.194	0.174	0.792	1	0.736	0.186	0.598	0.576	0.810	-0.287	0.523	0.909	0.658	-0.378	0.414	0.505	0.836	0.336
CEY LN	0.518	0.031	0.631	0.736	1	0.289	0.105	0.213	0.736	-0.535	0.656	0.654	0.712	0.049	0.552	0.795	0.396	-0.067
CFFAU US	-0.156	0.394	0.258	0.186	0.289	1	-0.356	-0.115	0.245	-0.294	0.224	0.243	0.416	0.511	0.328	0.492	-0.175	-0.065
CLX US	-0.371	-0.077	0.402	0.598	0.105	-0.356	1	0.877	0.392	0.445	0.025	0.593	0.040	-0.912	0.090	-0.130	0.827	0.806
CTXS US	-0.491	-0.303	0.477	0.576	0.213	-0.115	0.877	1	0.431	0.301	0.097	0.599	0.133	-0.857	0.270	0.004	0.731	0.808
EA US	0.332	0.262	0.963	0.810	0.736	0.245	0.392	0.431	1	-0.246	0.877	0.892	0.884	-0.151	0.121	0.819	0.760	0.041
HCCHU US	-0.596	0.103	-0.307	-0.287	-0.535	-0.294	0.445	0.301	-0.246	1	-0.473	-0.087	-0.584	-0.521	-0.285	-0.410	0.003	0.563
HSTM US	0.543	0.226	0.876	0.523	0.656	0.224	0.025	0.097	0.877	-0.473	1	0.623	0.928	0.181	-0.100	0.841	0.503	-0.327
NFLX US	0.139	0.324	0.884	0.909	0.654	0.243	0.593	0.599	0.892	-0.087	0.623	1	0.660	-0.389	0.140	0.586	0.805	0.372
PG US	0.437	0.247	0.881	0.658	0.712	0.416	0.040	0.133	0.884	-0.584	0.928	0.660	1	0.232	0.160	0.862	0.544	-0.281
PHGE/U US	0.396	0.265	-0.179	-0.378	0.049	0.511	-0.912	-0.857	-0.151	-0.521	0.181	-0.389	0.232	1	-0.054	0.331	-0.634	-0.812
SBRY LN	-0.087	-0.309	0.012	0.414	0.552	0.328	0.090	0.270	0.121	-0.285	-0.100	0.140	0.160	-0.054	1	0.258	0.080	0.176
SPAQ/U US	0.496	0.292	0.712	0.505	0.795	0.492	-0.130	0.004	0.819	-0.410	0.841	0.586	0.862	0.331	0.258	1	0.277	-0.342
WMT US	0.023	0.063	0.788	0.836	0.396	-0.175	0.827	0.731	0.760	0.003	0.503	0.805	0.544	-0.634	0.080	0.277	1	0.427
ZM US	-0.699	-0.056	0.080	0.336	-0.067	-0.065	0.806	0.808	0.041	0.563	-0.327	0.372	-0.281	-0.812	0.176	-0.342	0.427	1

## 12.6 Interpretation of results

Having calculated the intrinsic value according to P/E ratio as well as the GGM price, these were then compared with the actual price. The actual price at this time was £54.91, meaning that the share was undervalued compared to the pricing methods.

The CAPM figures were plotted on an SML line to determine if they were overvalued or undervalued, in this case the ATVI stock was undervalued which coincides with the findings from P/E and GGM.

Additionally, a correlation matrix was created (figure 16) to check that ATVI wasn't too highly correlated with assets already in the portfolio, having analysed correlation and combined with information from other methods, the decision was made to purchase the stock.

The Security Market Line is shown in the main body in section 2.2.2.

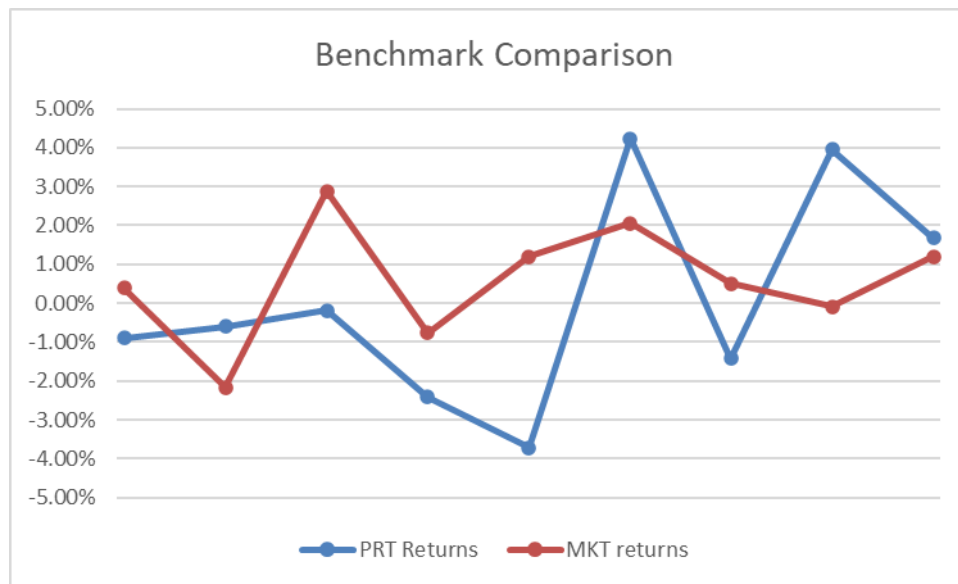
There was 11 shares sold and 9 bought over the duration of the active investment. Every buy/sell decision was prone to a similar level of investigation as shown above for ATVI. A full log is available in appendix 8.

## 13. Appendix Seven – Evaluation of portfolios performance

### 13.1) Portfolio Performance

While the portfolio was profitable, it did not beat the S&P benchmark. The portfolios cumulative return was 0.64% while the markets was 5.24% for the same time period. This 10 week period was particularly volatile due to coronavirus pandemic, as demonstrated in figure 17. This graph compares the portfolios weekly performance to the markets, we can see that the portfolio outperformed the market in recent weeks however the losses in the first weeks were to severe for the portfolio to catch up.

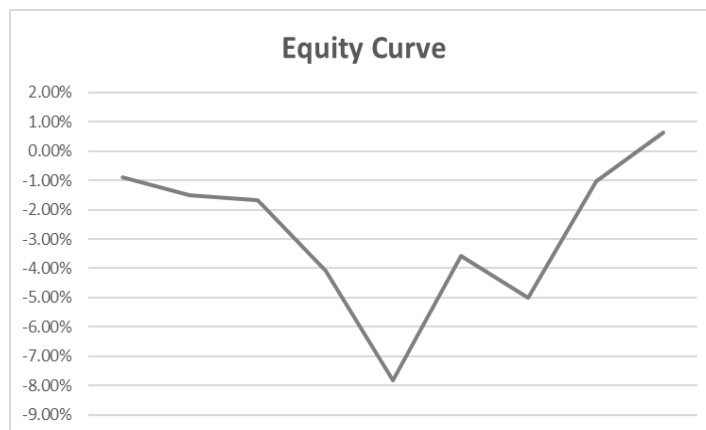
Figure 17



### 13.2) Weekly profits/loss

The portfolio won 1/3 trades, with the highest weekly loss of -3.72% on 23/03/2020 and the highest weekly return of 4.24% the following week on 30/03/2020. Figure 18 charts an equity curve to demonstrate portfolio fluxuations. An ideal curve would be a constant rise however the volatility caused a period of harsh ups and downs.

Figure 18



### 13.3) Coefficient of Variation Ratio (CV)

The coefficient of variation ratio is the ratio of the standard deviation to the mean, it helps determine how risky an asset is in relation to expected return (Brown, 1998).

In this case, the portfolio was beaten by the benchmark as the portfolio CV was 4.92 and the benchmark CV was 0.29. The lower the value, the better, however while the benchmark outperformed the portfolio, the portfolios CV ratio is still quite low.

**Portfolio CV = 4.9197**

**Benchmark CV = 0.2902**

*FORMULA: Standard Deviation divided by Mean Return*

### 13.4) Sharpe Ratio

The Sharpe ratio measures the expected portfolio return per unit of risk. It helps describe how investment return compensates the investor for the level of risk undertaken (Sharpe, 1994; Schmid & Schmidt, 2010). The benchmark performs better than the portfolio showing that the portfolio provides less return per unit of risk.

**Portfolio Sharpe = 0.1195**

**Benchmark Sharpe = 3.2942**

*FORMULA: (Portfolio Return – RFR) divided by standard deviation  $\sigma$*

### 13.5) Treynor Ratio

Treynor ratio is similar to Sharpe in that it demonstrates return per unit of risk, however it uses market risk (beta) as opposed to total risk (standard deviation). (Hübner, 2005). Similar to the results of Sharpe, the portfolio is outperformed by the benchmark.

**Portfolio Treynor = 0.0561**

**Benchmark Treynor = 0.3369**

*FORMULA: (Portfolio Return – RFR) divided by Beta  $\beta$*

### 13.6) Jensen's Alpha

Jensen's Alpha is a measure of the excess return of an asset compared to the return predicted by CAPM (Jensen, 1968; Ms, 2015). The result for this portfolio was 0.11 or -11%. This means that the portfolio underperformed the CAPM expectation by 11%.

**Jensen's Alpha = -0.11**

*FORMULA: (Portfolio Return – RFR) – (Beta (Market Return – RFR))*

### 13.7) M2 ratio

Mogdigliani ratio, commonly referred to as M2 is an extension of the Sharpe ratio, it measures the returns of a portfolio, adjusted for risk and relative to the chosen benchmark.

$$\text{M2 ratio} = 0.0277$$

*FORMULA:  $M2 = (\text{Sharpe} * \text{Benchmark } \sigma) + RFR$*

### 13.8) Calmar Ratio

Calmar is used to measure performance relative to risk. A low calmar ratio indicates the portfolio does not perform well on a risk-adjusted basis. The portfolios calmar ratio is very low, especially compared to the benchmark.

$$\text{Portfolio Calmar Ratio} = 0.5440$$

$$\text{Benchmark Calmar Ratio} = 5.0948$$

*FORMULA: Annual Rate of Return divided by Maximum Drawdown*

### 13.9) Tracking Error

Tracking Error measures the difference in the return fluctuations of the investment portfolio against the return fluctuations of the benchmark using standard deviation.

In this portfolio, tracking error signifies that the portfolio outperformed the benchmark but only slightly.

$$\text{Tracking Error} = 0.1910$$

### 13.10) Information Ratio

Information ratio is a measure of the risk-adjusted returns of an asset relative to a chosen benchmark. The negative result in our portfolio shows that the portfolio did not provide a higher return than the benchmark.

$$\text{Information Ratio} = -1.5077$$

*FORMULA: (Portfolio return – Market return) divided by tracking error*



## 14. Appendix Eight - Log of Purchases

Each purchase involved a process of research and calculations to make informed and wise investment decisions. The investor aimed to only purchase shares that were undervalued according to P/E ratio, with a low beta (Less than one) and low correlation (correlation with less than half of the portfolio). In accordance with (Fawcett & Provost, 1999), new sources were monitored to help gain insights into good investments. News sources were interpreted to make good predictions, such as the transition to online learning in schools and universities, which lead to investments into Zoom and Citrix.

### 02/03/20

At this time, the global coronavirus pandemic was just beginning to hit the western world and 'panic shopping' became an issue. The investor felt that this was an opportunity to profit by investing in supermarket chains.

#### **Bought WMT US @112.91**

Intrinsic value was calculated at 114.18, meaning that this share was undervalued  
Beta of 0.58, deemed appropriate for the portfolio as it was well below the market beta of 1.  
Walmart showed low correlation with most of the portfolio and negative correlation with two assets.

#### **Bought SBRY LN @2.043**

Intrinsic value was calculated at 4.93 meaning that this share was undervalued  
Beta of 0.6, deemed appropriate for the portfolio as it was well below the market beta of 1.  
Sainsburys only had high correlation with one asset in the portfolio and had low or no correlation with the rest.

### 09/03/20

#### **Bought NFLX US @315.25**

Intrinsic value was calculated at 375.44 meaning that this share was undervalued  
Beta of 1.08, slightly over the market beta of one, however deemed a safe investment as it was significantly undervalued.  
Netflix had little or no correlation with the portfolio, out of all the purchase decisions this was the most correlated asset.

In hindsight, this was a slightly risky decision, with correlation and beta as possible obstacles, however the investor felt that the lockdown in many countries would lead to an increase in use of streaming services, this risk paid off and was a profitable purchase.

### 16/03/20

At this time, the pandemic had led to national lockdowns, the decision was made to investment in industries that were likely to rise in this situation, including video games, streaming services and online learning.

#### **Bought ATVI US @54.91**

Intrinsic value was calculated at 66.75 meaning that this share was undervalued  
Beta of 0.92, deemed appropriate for the portfolio as it was below the market beta of 1.  
Activision showed little or no correlation with more than half of the portfolio

**Bought EA US @90.06**

Intrinsic value was calculated at 100.14 meaning that this share was undervalued  
Beta of 0.83, deemed appropriate for the portfolio as it was well the market beta of 1.  
EA showed little or no correlation with more than half of the portfolio

**Bought PG US @110.83**

Intrinsic value was calculated at 110.01 meaning that this share was slightly overvalued.  
Beta of 0.65, deemed appropriate for the portfolio as it was well below the market beta of 1.  
P&G showed little or no correlation with more than half of the portfolio

**Bought ZM US @123.77**

Intrinsic value was calculated at 134.80 meaning that this share was undervalued  
Beta of -0.1, deemed appropriate for the portfolio as a negative beta will move opposite the market.  
Zoom showed the highest level of negative correlation, meaning that it would react in the opposite way to the market. Having negatively correlated assets is important as it hedges risk, any drops in the market will lead to gains in the portfolio.

**Bought CTXS US @125.31**

Intrinsic value was calculated at 141.57 meaning that this share was undervalued  
Beta of 0.75, deemed appropriate for the portfolio as it was below the market beta of 1.  
Citrix showed little or no correlation with more than half of the portfolio

**Bought CLX US @176.12**

Intrinsic value was calculated at 173.23 meaning that this share was slightly overvalued.  
Beta of 0.39, deemed appropriate for the portfolio as it was well below the market beta of 1.  
Clorox showed little or no correlation with more than half of the portfolio

## 15. Appendix Nine – VAR Methods

### Monte Carlo Simulation

FORMULA: CELL D1 = Expected Return\*Time + Standard Deviation\*normsinv\*  $\sqrt{Time}$

PERCENTILE(D1, 5%) **FOR 95% CONFIDENCE**

### Monte Carlo Simulation - Method

Table 12

	=RAND	=NORMSINV	
1	0.953698639	1.681825296	0.18578816
2	0.825527538	0.936637757	0.033284428
3	0.887384122	1.212733425	0.102794239
4	0.551670228	0.129882306	0.016660306
5	0.343808588	-0.402090838	-0.07766937
6	0.156698468	-1.008119835	-0.058784988
7	0.103481543	-1.26196026	0.003208695
8	0.434799708	-0.164167334	0.003208695
9	0.414179738	-0.216806077	0.003208695
10	0.154638283	-1.016741189	0.003208695

### Monte Carlo Simulation - Results

Table 13

MCS Given VAR	90%	95%	99%
	-£30,294.97	-£43,912.19	-£54,805.96

### Variance Covariance

FORMULA: = Investment amount \* Standard deviation \* Z Value

### Variance Covariance Method

Table 14

	Investment	£750,000.00
	Mean Return	0.18%
SD	Portfolio Signma	4.51%
	Mean Investment	£751,329.79
SD	Sigma Investment	£33,859.37

### Variance Covariance Results

Table 15

VCV Given VAR	90%	95%	99%
	-£42,062.74	-£54,363.92	-£77,438.89

### Historical Simulation

FORMULA: PERCENTILE(portfolio returns, 5%) \* portfolio value **FOR 95% CONFIDENCE**

#### Historical Simulation – Method

Table 16

Value	Returns	
Portfolio	Portfolio Return	Benchmark return
£750,000.00		
£772,168.68	2.96%	-1.25%
£710,370.18	-8.00%	-11.49%
£746,514.23	5.09%	0.61%
£678,863.32	-9.06%	-8.79%
£688,416.54	1.41%	-14.98%
£712,371.39	3.48%	10.26%
£727,029.06	2.06%	-2.08%
£725,659.21	-0.19%	12.10%
£799,062.24	10.12%	3.04%
£806,244.98	0.90%	-1.32%

#### Historical Simulation – Results

Table 17

HS Given VAR	90%	95%	99%
	-£60,818.55	-£64,392.67	-£67,251.97

