Group Coursework Submission Form

Specialist Masters Programme

Please list all names of group members: (Surname, first name) 1. Patel, Prachin 2. Rusakov, Lachezar 3. Shen, Zhao 4. Wan Jinda	**GROUP NUMBER:**	**8**
MSc in: Financial Mathematics, Mathematical Trading & Finance, Quantitative Finance		
Module Code: SMM265		
Module Title: Asset Pricing		
Lecturer: Dr Dirk Nitzsche	**Submission Date:** **24/11/2023**	

Declaration:

By submitting this work, we declare that this work is entirely our own except those parts duly identified and referenced in my submission. It complies with any specified word limits and the requirements and regulations detailed in the coursework instructions and any other relevant programme and module documentation. In submitting this work we acknowledge that we have read and understood the regulations and code regarding academic misconduct, including that relating to plagiarism, as specified in the Programme Handbook. We also acknowledge that this work will be subject to a variety of checks for academic misconduct.

We acknowledge that work submitted late without a granted extension will be subject to penalties, as outlined in the Programme Handbook. Penalties will be applied for a maximum of five days lateness, after which a mark of zero will be awarded.

Marker's Comments (if not being marked on-line):

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For Students:
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Group 8: Prachin Patel, Lachezar Rusakov, Zhao Shen, Jinda Wan

Asset Pricing Coursework

Question 1: Modern Portfolio Theory

Details		Weights			
Asset Number	Asset Name	min18	opt18	min23	opt23
5	BUNZL	0.37580706	1	0.23563262	0
6	ROLLS-ROYCE HOLDINGS	0.03194946	0	0.02655842	0
7	EASYJET	0.07054041	0	0	0
12	BAE SYSTEMS	0.09326832	0	0.26690828	0.76722542
16	SEVERN TRENT	0.42843475	0	0.47090068	0.23277458

Table 1

Details	Terminal Wealth
min18	1199.954
opt18	1212.598425
min23	1328.565
opt23	1513.259735
equal weights (no rebal.)	1025.407
equal weights (annual rebal.)	1535.726705
risk free invest.	1060.485811
FTSE 100	1013.033

Table 2

Key Assumptions

1. The team formed a portfolio comprising stocks from diverse industries to leverage the benefits of diversification, aiming to capitalize on the fact that these stocks are not strongly positively correlated.
2. All the computations were done on the basis of annualised log returns
3. The calculated annualized risk-free rates were 2.423% and 1.34% for the periods preceding and following the conclusion of September 2018, respectively.
4. Short selling of stocks is not allowed therefore negative weights of stocks in portfolios is not possible.
5. Market has no frictions that is no transaction costs and perfect liquidity.

Analysis

As expected, the minimum variance portfolio, Min18 (Table 1), had portfolio weightings in all the stocks which would allow investors to diversify the idiosyncratic risk of the individual stocks. The portfolio performance for Min18 is such that investors get an expected annual return of 4.7% and the annual volatility of 13.7%. However, the weightings for the minimum variance portfolio for the period ending 2023 only suggests investing in 4 of the 5 stocks where investors are expected an annual return of 4.2% while facing the annual volatility of 14.6%. Observing that investors had to face more risk while getting lesser returns going against the conventional relationship in finance. This is because of the extraneous event of the Global Pandemic where the aviation industry faced the largest negative returns as international and domestic travel was suspended therefore no weighting was given to EASYJET. Another great change in the portfolio weightings over the 2 time periods is that there is a shift in the allocation from the stock BUNZL to BAE SYSTEMS. One of the leading reasons was the rise of uncertainty in the global economy mainly due to the Russia-Ukraine war and rising interest rates which caused investors to move from logistics companies to defense stocks. As supply chain and distribution companies were struggling because of the strict measures undertaken by countries during the Pandemic, especially China, one of the biggest manufacturing and shipping countries. SEVERN TRENT had the highest weighting in both the periods as utility stocks are deemed to be much safer since they have lower volatility, high dividend payouts and low betas. To maximize the Sharpe ratio investors should construct the portfolio weights as per Opt18 (Table 1) which suggests only investing in one stock which is BUNZL. This cross checks with the fact that BUNZL had the highest Sharpe ratio of 0.33 compared to the other 4 stocks and the portfolio Min18. This also aligns with the fact that investors get the highest expected returns of 8.54% from BUNZL while taking on the second lowest risk of the 5 stocks, 18.39%. On the other hand, for the period ending 2023, Opt23 (Table 1) the portfolio weights change drastically such that it is optimal to only invest in 2 stocks with majority of the proportion being in BAE SYSTEMS and followed by SEVERN TRENT. Both the stocks had the highest Sharpe Ratio of 0.35 & 0.1 respectively which checks out with the previous macroeconomic analysis. Comparing the minimum variance portfolio and optimal portfolio weights one notices that the number of stocks in the minimum portfolio weights are greater than in optimal portfolio across both time periods. As modern portfolio theory suggests achieving diversification benefits investors should construct portfolios with greater number of assets that are not as positively correlated.

Looking at the terminal wealth for all the 4 portfolios in Table 2, it is obvious that optimal portfolios Opt18, Opt23 outperform the minimum variance portfolios Min18, Min23 portfolios as they take on more risk in search for higher return. Also note that the terminal wealth of investing in the FTSE100 is significantly lower than from investing at the monthly risk-free rate. Moreover, all 4 of the portfolios outperform the market index FTSE100 and the UK STERLING 1M DEPOSIT (FT/RFV) - MIDDLE RATE when looked at the time horizon from end of September 2018 to end of September 2023. Even when compared to an equally weighted portfolio with no annual rebalancing the portfolios outshine in terms of returns. Nevertheless, for investors to truly maximize their terminal wealth they should annually rebalance their equally weighted portfolio to get the highest return of the possible alternatives mentioned which is 60.48%. Having said that the Min18 and Opt18 portfolios underperform than Min23 and Opt23 which suggests that taking data from too back in the past does not improve the forecastabilty of returns in the future.

Thereby, the team recommends not using the weights from Min23 and Opt23 for investing on October 23 since it is more advantageous to use recent relevant data post structural breaks that is a dataset without exogeneous events like the global pandemic.

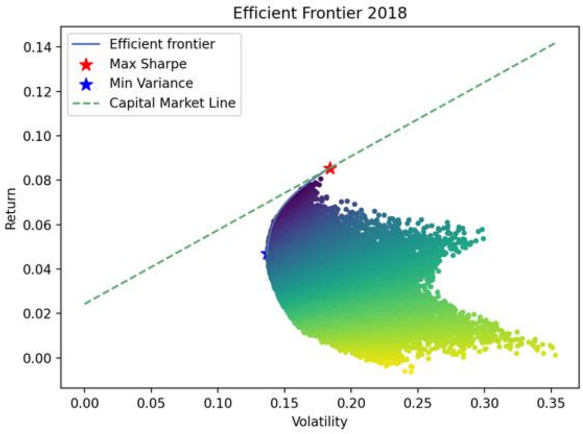


Figure 1

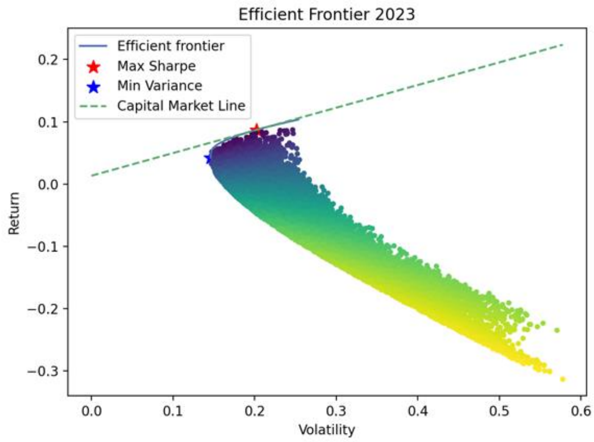
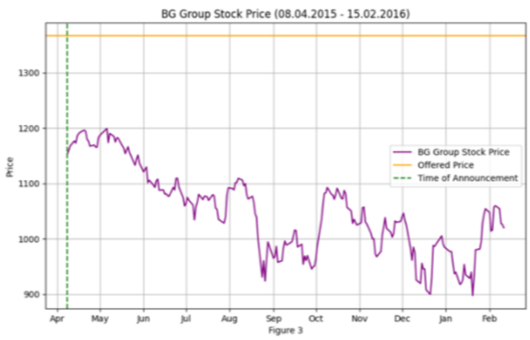


Figure 2

The team simulated 25000 portfolios with different weights to plot the efficient frontiers and for the Capital Market line used the the annual risk-free rate for the y-axis intercept and the slope being the portfolio with the maximum Sharpe ratio. Now comparing the efficient frontiers for the 2 time periods one notices that the 2023 efficient frontier has higher number of suboptimal portfolios that is higher risk with negative returns compared to Figure 1 where a good proportion of portfolios have high risk but still provide some positive returns. Since the dataset for the 2nd time period has comparatively much fewer observations and faced higher uncertainty due to unforeseen circumstances in a shorter period of time. The shape of the efficient frontiers is significantly different as in Figure 2 it is very closely tangential to the Capital Market Line whereas in Figure 1 it tends to move towards the Capital Market Line at a steeper angle.

Question 2: The acquisition of BG Group by Royal Dutch Shell



Key Details

Announcement Date: **April 8, 2015**
Completion Date: **February 15, 2016**
Deal Value: Approximately **£47 billion**
Price per Share: Approximately **1,367 GBX**

Summary

In a pivotal financial move to fortify its presence in the lucrative liquefied natural gas (LNG) market, Royal Dutch Shell, a global force in the oil and gas industry, strategically announced the acquisition of BG Group, a distinguished British multinational specializing in oil and gas exploration, production, and LNG operations, on April 8, 2015. This financial transaction, valued at approximately £47 billion or approximately 1,367 GBX, was significantly above the trading price at the time as shown of Figure 3. It underscored a purposeful alignment of financial capabilities and strategic assets. As regulatory bodies scrutinized the proposal, Shell adeptly navigated the intricacies, securing the requisite approvals for the acquisition. Shareholders from both BG Group and Shell rallied behind the deal, recognising the potential financial advantages arising from the integration of these two companies. On February 15, 2016, the deal reached its financial pinnacle, with BG Group seamlessly integrating into the Royal Dutch Shell portfolio. This financial integration, extending beyond the mere aggregation of financial assets and portfolios, sought to leverage the combined financial strengths of both entities, establishing a more financially robust and competitive presence in the dynamic energy market. The financial implications of the acquisition were profound, positioning Royal Dutch Shell as a financial leader in the global LNG market. BG Group's specialized financial capabilities in LNG production and exploration complemented Shell's long-term strategic financial objectives. The financial impact of the acquisition underscored a broader financial trend within the energy sector, wherein major financial entities strategically consolidated to enhance financial competitiveness, streamline financial operations, and adapt to evolving financial market dynamics.

Analysis

In a hypothetical investment on the day after the announcement the returns of the investment for the first 10 days are as follows:

Day 1	0.60%
Day 2	1.29%
Day 3	2.05%
Day 4	1.71%
Day 5	2.81%

Day 6	3.14%
Day 7	3.35%
Day 8	3.69%
Day 9	3.48%
Day 10	2.29%

During the period 08.05.2015 – 15.02.2016, the investment experienced a cumulative return of -8.78%. This negative cumulative return indicates a decline in the overall performance of the investment over this time frame. This is clearly shown on Figure 4. The aggregate stock market indicator, in this case the FTSE 100 Index, experienced cumulative return of -17.87%. In comparison the investment in BGC Group outperforms the aggregate index, which is visually evident on Figure 4.

The returns of BG Group for the period 08.04.2015 – 15.02.2016 have a mean of -0.000409 and a standard deviation of 0.017999, while the index have a mean of -0.000827 and a standard deviation of 0.012321. This data suggests that the expected return of the BG Group is bigger (less negative), but it is associated with more risk as the standard deviation is also bigger.

If we assume a risk-free rate of interest of 0.45% (which is in line with the date from the same time period) we can calculate sharp ratios of −0.264 for BG Group and −0.695 for the FTSE 100 index. The negative values still suggest that, on a risk-adjusted basis, the returns did not compensate for the risk taken. However the higher (less negative) Sharpe Ratio of BG Group suggests reletevely better risk adjusted performance compared to the index.

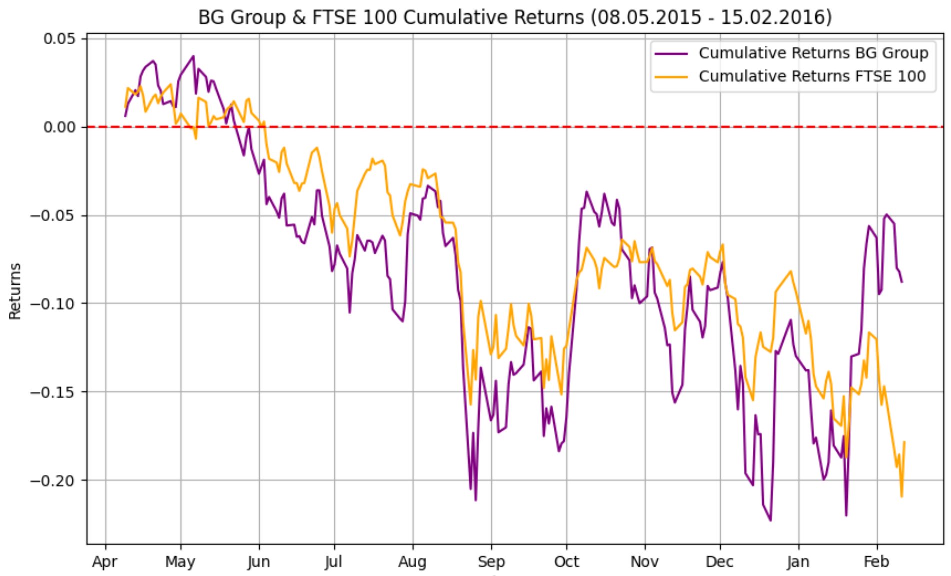


Figure 4

According to the results generated from BG Group, which has a cumulative return of -8.78% and Sharpe ratio −0.264 and standard deviation 0.017999, compared with the plot of efficient frontier 2018, the BG Group has a relatively higher risk and lower return, as a result, it is certainly that the BG Group should not be include in the portfolio.