EFFICIENT FRONTIER & CAPITAL MARKET LINE

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1. Introduction

The efficient frontier is the set of optimal portfolios that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. Portfolios that lie below the efficient frontier are sub-optimal because they do not provide enough return for the level of risk. Portfolios that cluster to the right of the efficient frontier are sub-optimal because they have a higher level of risk for the defined rate of return.

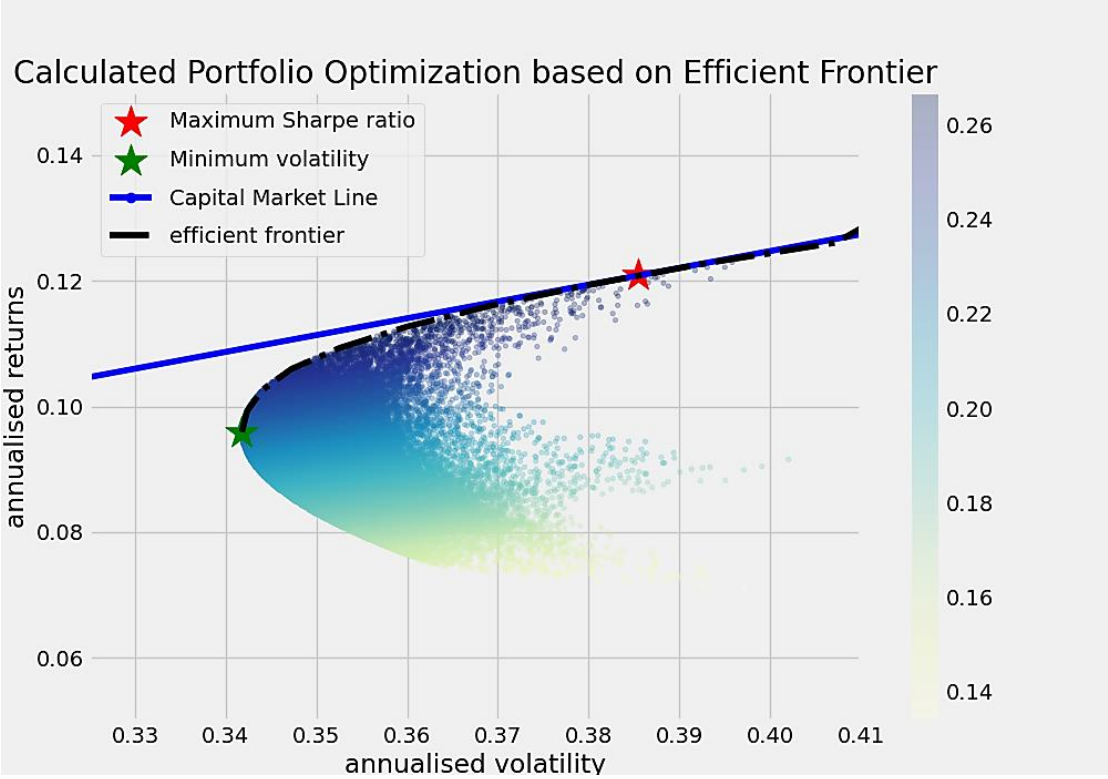
The capital market line (CML) represents portfolios that optimally combine risk and return. It is a theoretical concept that represents all the portfolios that optimally combine the risk-free rate of return and the market portfolio of risky assets. Under the capital asset pricing model (CAPM), all investors will choose a position on the capital market line, in equilibrium, by borrowing or lending at the risk-free rate, since this maximizes return for a given level of risk.

2. Data

I use the stock price series from 4 banks in Vietnam, namely, MB Bank, VIB, Viettinbank and BIDV for a period of 2 years (2021 - 2022), equivalent to 499 trading days. The price in this case is the closing price of these stocks. Data is extracted from cophieu68.vn.

Time	MBB	VIB	CTG	BID
2021-01-04	17.5784	16.7084	26.8478	38.1861
2021-01-05	18.4591	17.8730	26.7721	37.9091
2021-01-06	18.7407	17.8983	28.6250	38.6213
2021-01-07	19.1852	17.7211	29.3813	38.7005
2021-01-08	19.7037	17.5945	29.2679	38.3839
...	...	...	...	...
2022-12-26	16.8000	17.5598	26.0500	38.8000
2022-12-27	17.2500	18.1818	26.6000	40.0000
2022-12-28	17.4500	18.1818	27.1500	41.9000
2022-12-29	17.4000	18.0861	27.0000	40.0000
2022-12-30	17.1000	18.1818	27.2500	38.6000

3. Efficient frontier with riskless asset line



Maximum Sharpe Ratio Portfolio Allocation

Annualised Return: 0.12

Annualised Volatility: 0.39

	MBB	VIB	CTG	BID
allocation	0.0	84.63	11.03	4.34

Minimum Volatility Portfolio Allocation

Annualised Return: 0.1

Annualised Volatility: 0.34

	MBB	VIB	CTG	BID
allocation	11.66	33.53	14.85	39.97

Comments on the results:

For minimum risk portfolio, we can see that nearly 40% of our budget is allocated in BID. VIB is accounted by 33.53% of the portfolio. The weights of CTG and MBB are 14.85% and 11.66% respectively.

If we are willing to take higher risk for higher return, one that gives us the best risk-adjusted return is the one with maximum Sharpe ratio. In this scenario, we are allocating a significant portion to VIB, which is quite volatile stocks from the previous plot of daily returns. And BID which had nearly 40% allocation in the minimum risk portfolio, has less

than 4.5% budget allocated to it. While MBB is not considered in this portfolio with maximum Sharpe ratio.

We can notice that while the difference in risk between minimum volatility portfolio and maximum Sharpe ratio portfolio is 5%, the difference in returns is a 2%.

We now consider what happens when a risk-free investment earning a return of 0.0178 is possible. This shows that when a risk-free investment is considered, the efficient frontier must be a straight line. There is a linear trade-off between expected return and standard deviation of return. This also shows that all investors should choose to invest in the same portfolio of risky assets. They should then reflect their risk appetite by borrowing or lending at the risk-free rate.

Portfolios that fall on the capital market line (CML), in theory, optimize the risk/return relationship, thereby maximizing performance. So, the slope of the CML is the Sharpe ratio of the market portfolio. As a generalization, investors should look to buy assets if the Sharpe ratio is above the CML and sell if the Sharpe ratio is below the CML.

APPENDIX

Dataset and code for this assignment can be found here: market-risk-maixbach