CF968 Industry Expert Lectures in Finance Assignment
Name: Han Ao
Registration Number: 1106057
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A Study for Attempting Designing Portfolios for Cautious/Income Investors and Growth Investors by Using Constrain Satisfaction

Introduction

This study aims to design portfolios for two types of investors – cautious/income investors and growth investors. It organised into two parts. First part introduces, theoretically, two different sets of metiers that attract different investors. Second part provides a more practical way – Constraint Satisfaction to optimize the portfolios for different types of investor.

Two Types of Investor

For the cautious/income investor, the portfolio should contain those stocks has following features:

1. Low Volatility
2. Low Debt to Equity Ratio
3. Chosen from Certain comparatively safe Sectors
4. Having ample cash
5. Good liquidity
6. High dividend yield
7. High dividend cover
8. Low Stock Price

The portfolio designed for growth investors should consisted with stocks having:

1. Medium volatility
2. Good record of growth and returns
3. Good forecast growth and returns
4. Positive cash flow
5. Increasing operation margin
6. High barrier to entry

Cautious/income investors are those who do not willing to take high risks and expect high profits. This group of investors can be seen as risk-aversion investors. As a cautious/income investor, the risk should be reduced as much as possible.

First, risks can be calculated in terms of volatility. For a stock, let r_i denote the stock's daily returns, the volatility is

$$\sigma = \sqrt{E\{(r_i - \mu)^2\}}$$

Where μ represents the average return for one stock during a certain period. For a portfolio has N stocks, the volatility measured as:

$$\sigma_p = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{i,j}}$$

Where $\sigma_{i,j}$ is the covariance between the returns of securities i and j. Showing the portfolio on the Markowitz frontier, the optimal point should be the very left

peak point. The lower the volatility of the portfolio, the lower risk an investor carries. This satisfies the definition of the cautious/income investors.

Second, debt/equity ratio is a metric that measures a company's financial leverage. It is calculated by dividing its total liability by stockholder's equity. It shows that by what ratio a company is financing its asset by rising debt. A high debt to equity ratio usually indicates that a company is financing its growth with a lot of debt. If a lot of debt is used, the company could potentially generate more earnings than it could have without the extra financing. However, if this were to increase earnings by a greater amount than the debt cost (interest), then the shareholders benefit as more earnings are being spread among the same amount of shareholders. However, the cost of this debt financing may outweigh the return that the company generates on the debt through investment and business activities and become too much for the company to handle. This can lead to bankruptcy, which would leave shareholders with nothing. Therefore, to the cautious/income investors, they tend to invest in low equity/debt ratio companies.

Third, when economy goes bad, some companies go bankruptcy, but some business does not effected by the 'bad weather' as much as some others. For example, Tesco satisfies people's daily necessaries. It is hard to see people not eating in bad times, while the industries like manufactures can be badly hurt. Cautious/income investors would like to see their income has a comparatively low various even in bad times.

Forth, cash flows are essential to solvency. They can be presented as the record of generating cash. Cash flow is crucial to a company's survival. Having enough cash on hand can ensure creditors, employees and others can be paid on time. If a business or person does not have enough cash to support its operations, it is said to be insolvent, and a likely candidate for bankruptcy should the insolvency continue. Obliviously, cautious/income investor will choose those companies who having ample cash on hand.

Fifth, liquidity is another main measure of safety. Usually, there are two definition of liquidity, first is that the degree to which an asset or security can be bought or sold in the market without affecting the asset's price. A high level of trading activity characterizes liquidity. Assets that can be easily bought or sold are known as liquid assets. Second, it is defined as the ability to convert an asset to cash quickly. Also known as "marketability". It is believed that it is safer to invest into liquid assets than illiquid ones for the reason that it is easier to withdraw the money that invested into the assets. Therefore, for cautious/income investors, they tend to see that the companies what they are investing in are holding more liquid assets than illiquid ones.

Sixth, dividend is defined as a distribution of a portion of a company's earnings. It is decided by the board of directors. High-growth companies rarely offer dividends because all of their profits are reinvested to help sustain higher-than-average growth. Dividends are always measured in terms of dividend yields, which is calculated as annual dividends per share over the price per share. To

the cautious/income investors, it is believed that the dividend yields is their main concern in order to gain income. As a result, to cautious/income investors, the higher the dividend yields, the worthier a stock. It matters not a company's growth.

Seventh, dividend cover is a measure of the ability of a company to maintain the level of dividend paid out. The higher the cover, the better the ability to maintain dividends if profits drop. This needs to be looked at in the context of how stable a company's earnings are: a low level of dividend cover might be acceptable in a company with very stable profits, but the same level of cover at company with volatile profits would indicate that dividends are at risk. Clearly, cautious/income investors do not want to put their dividends into risk. So they prefer those companies with high dividend cover ratio.

Eighth, stock price is directly related to the benefits. Consider the dividend yields is calculated as annual dividends per share over the price per share. The higher the stock price, the lower the dividend yields an investor can earn, ceteris paribus.

In a word, cautious/income investors prefer steady but comparatively lower income more than higher income with bearing more risks. All the 8 factors above are making sure that cautious/income investors are carrying minimum risks at the same income (dividends) level.

Another different investing strategy is called growth investing. Growth investing is strategy whereby an investor seeks out stocks with what they deem good growth potential. In most cases a growth stock is defined as a company whose earnings are expected to grow at an above-average rate compared to its industry or the overall market. Growth investors wish to bear higher risks and expecting corresponding higher returns. To achieve this goal, there is a series preferences need to be satisfied.

First, growth investors are seen as risk-neutral investors of which bear risks and desire corresponding returns. The stocks above average returns with medium risks are their targets, while high risks sometimes suggest higher returns but unhealthier. A stock with sound growth history, appear less volatile, also show a picture of lower risks. Unlike speculators always betting for high risks and expecting high returns (or high lost), the growth investors care more about a company's healthy growth (not a speculation chance). Therefore, growth investors are more likely to buy those stocks with medium risks (volatility).

Second, because all the forecasting and other data analysis (either technical analysis or empirical study) are derived from the history data, in another word, the evidence of judging a company is the history data. A sound record of growth and returns history is the key to judge if a company has the possibility to growth or not. It seems like that a company with good record of growth and returns is more likely to be seen to grow. As growth investors are exactly investing in such possibility, they tend to invest those companies who have good records of growth and returns.

Third, the reason that we perform data analysis, pattern studies or other studies on a stock history data is ultimately because we are looking for the growth potential. Not all stocks with sound history can potentially grow, though they have higher probability. Only those who have the good forecast growth and returns are considered as investable stocks to growth investors.

Forth, positive cash flow means that the cash inflows during a period are higher than the cash outflows during the same period. And it is usually due to a careful management of cash inflow and expenditure. This at least tells us that a company with positive cash flow is accumulating wealth, for they are earning more than spending. And this is exactly what growth investors' concern.

Fifth, operating margin is calculated as profit over turnover (sales). It gives analysts an idea of how much a company makes (before interest and taxes) on each pound of sales. When looking at operating margin to determine the quality of a company, it is best to look at the change in operating margin over time and to compare the company's yearly or quarterly figures to those of its competitors. If a company's margin is increasing, it is earning more per pound of sales. The higher the margin, the better. Increasing operating margin indicates a growing quality of a company. To the growth investors, increasing operating margin means a company's growth.

Sixth, the entry barrier (also known as barriers to entry) is start-up costs or other obstacles that prevent new competitors from easily entering an industry or area of business. Barriers to entry benefit existing companies already operating in an industry because they protect an established company's revenues and profits from being whittled away by new competitors. Therefore the high barriers to entry make the companies already in the industry safer and more beneficial. And this is what the growth investors wish to observe.

Above six points make the growth investors a complete criteria list for choosing stocks and building a portfolio to invest.

The two lists of features above provide a general range for both types of investor to invest. Yet, clearly, it is not good enough to just allow investors to randomly pick stocks in that range by random weights. And it is not a good design at all.

Constraint Satisfaction

The decent deign of portfolios should be one that maximize the utility and satisfies all the features listed above. The problem is how can one (both cautious/income investors and growth investors) choose a set of stocks from a vast number of stocks? What is an optimal portfolio?

The Markowitz frontier theory provides an approach stating that there is a trade-off between risks and returns. Investors can always find points either bearing the lowest risks at the same return level or have the highest returns at the same risk level, these points consist the efficient frontier. All points on the

efficient frontier are optimal points. Investors should choose any points on the frontier based on there utility function. In practice, a way of finding an optimal portfolio is using Constraint Satisfaction Approach.

First of all, constraint satisfaction problem is a decision problem what have a given number of decisions to make and decisions constrain each other. Picking a stock into a portfolio can be seen as a decision.

Therefore, for both cautious/income investors and growth investors, the portfolio-designing problem can be recognized as constrained satisfaction problem.

Assume that we are going to pick out 10 stocks from FTSE 350 (which assumed have 350 stocks) to invest. On each stock, we are going to invest 10% of our total wealth.

For cautious/income investors, each stock picked must satisfies the constraints:

1. Low Volatility
2. Low Debt to Equity Ratio
3. Chosen from Certain comparatively safe Sectors
4. Having ample cash
5. Good liquidity
6. High dividend yield
7. High dividend cover
8. Low Stock Price
9. Investing 10% of total wealth

Therefore, let x_i denote 350 variables (350 stocks). Each variable has a set of value of assignments: $v, d_e, s, c, l, d_y, d_c, p, w$. All the assignments are 1 or 0. To illustrate, set a series of benchmarks: $V, D_e, S, Ca, L, D_y, D_c, P, W$. If a stock:

1. Its volatility is smaller than V, then $v = 1$, otherwise 0
2. Its Debt to Equity Ratio is smaller than D_e, then $d_e = 1$, otherwise 0
3. Is chosen from certain comparatively safe sectors S, then $s = 1$, otherwise 0
4. Has a enough cash Ca on hand, then $c = 1$, otherwise 0
5. Has a better liquidity than L, then $l = 1$, otherwise 0
6. Has a higher dividend yield than D_y, then $d_y = 1$, otherwise 0
7. Has a higher dividend cover than D_c, then $d_c = 1$, otherwise 0
8. Has a lower stock price than P, then $p = 1$, otherwise 0
9. Has been chosen to invest W: 10% of total value, then $w = 1$, otherwise 0

With an exception of w, all the values of $v, d_e, s, c, l, d_y, d_c, p$ are determined from historical data (reports, data analysis), in another word, are constants. ws are assigned randomly, variables.

Therefore, the optimal problem can be now formulated into a constraint satisfaction problem:

$$Z = x_i(v \cdot w, d_e \cdot w, s \cdot w, c \cdot w, l \cdot w, d_y \cdot w, d_c \cdot w, p \cdot w, w)$$

$$D_x = \{(0,1), (0,1), (0,1), (0,1), (0,1), (0,1), (0,1), (0,1), (0,1), \}$$

$$C: \sum_{i=1}^{350} x_i = \{10, 10, 10, 10, 10, 10, 10, 10, 10\}$$

Where i = 1~350, x_i denotes the whole 350 stocks set, D_x represents the domain of each stock, which is binary. Consequently, the constraints can be represented as $C.w$ represents that there are at most 10 stocks can be selected into the portfolio, 0 represents invest 0, 1 represents invest 10%.

Any portfolios that satisfy the constraint C also satisfies the original 8 features that cautious/income investors consider and the statement of investing 10% of total wealth separately on 10 stocks. However, similar to the Markowitz frontier theory (only those on the frontier are choices), obviously, not all solutions are the choices to the investors. Therefore, an optimization is required.

To optimize the portfolio under the Constrain Satisfaction Problem (CSP), approach like Hill-Climbing can be used.

To use Hill-Climbing, a performance function is necessary to measure a portfolio's performance. To cautious/income investors, the main concern is the dividend. Therefore, a performance function can be $f(d_y)$, which is a function of dividend yield.

Another function is needed to calculate if a portfolio violates any constraint. It is called cost function, say, $H(C)$. This measures how many constraints that a portfolio violates. Then define a new function $g(d_y) = f(d_y) - H(C)$, which is used for evaluate a portfolio.

And last, a neighbourhood function is required to make the portfolio evolve. As the only value that is assigned by investor – w, it is first randomly assigned to all the 350 variables. Then, a sequence of 1s and 0s is generated. The neighbourhood function is the one chose 1 w from 350, and changes its value (from 1 to 0, or 0 to 1). Then, re-evaluate the portfolio, and compare it to the original one. If the new one has a higher performance, then record the new one (climbed to a higher point). If it is lower, then pick another variable to change its value till it appears a higher performance (looking around).

When it appears no higher point than the current one, it is said to be reached a local optimal point, the local optimal point may be the global optimal point, but never for sure. As a result, it needs to be searched the rest area. To escape from a local optimal point, there are a number of ways. The method employed here is so called Taboo search. Taboo search keeps a Taboo list what records those positions where have been at. When a local optimal point has been reached. It keeps 'looking around' excluding the local optimal point. In another word, it will go to the sub-optimal point, and then from the sub-optimal point, it keeps going

ahead. If there is no point that is higher than the current optimal point, it is believed that the current optimal point is the global optimal point. On the global optimal point, the sequence of 350 *ws* record the weights that to invest on each stock for the optimal portfolio.

Similarly, for the growth investors, we only need to use different benchmarks and change the performance function to one that related to the returns and the risks (Sharpe ratio).

As a result, the complete portfolio designs are the optimized portfolios (highest-so-far points) satisfying all constraints (features) listed in the first part.

However, one of the weak points of Hill-Climbing is that you never know if you are at the highest point or not. What can be achieved is a best-so-far result. Another weak point is of the method employed in this study is that it needs a large number of data to set all the benchmarks and to judge the stocks parameters' satisfaction. Lacking the data directly leads to another weak point of this study, failure to implementation. Without the data, it cannot only provide actual portfolios, but offers a theoretical possibility instead. A final weak point is that the assumption 'picking out 10 stocks from 350 and investing 10% of total value on each one' seem to tight, it seems can only be used for illustration.

Conclusions

To sum up, this study analyzed the cautious/income investors and growth investors' investment styles. Originated from the styles, Constraint Satisfaction was employed to design portfolios for both cautious/income investors and growth investors. However, as a result of data lacking, this study only provided a method of generating such portfolios satisfying the investment requirements of both cautious/income investors and growth investors. In future studies, to implement (programming) this method a vast number of data set is necessary.